SUPPORT TO AIDS TREATMENT PROGRAMS: ESTIMATES OF THE ECONOMIC RETURN ON INVESTMENT

Working Paper

Investing in our future
The Global Fund
To Fight AIDS, Tuberculosis and Malaria

LIST OF ABBREVIATIONS

ARV	antiretroviral
VSL	value of a statistical life
VSLY	statistical value per life-year

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EXECUTIVE SUMMARY

1. As of the end of 2009, the Global Fund to Fight AIDS, Tuberculosis and Malaria had disbursed US$ 5.7 billion for HIV programs in low- and middle-income countries. Programs financed by the Global Fund were providing antiretroviral (ARV) therapy to 2.5 million people. According to targets of approved grants, this number is continuing to grow, to reach 3.5 million people on ARV therapy by the end of 2011.

2. This study estimates the economic returns that Global Fund-supported ARV therapy services and their associated health benefits can generate over the 11-year period 2011 to 2020. The presented new model quantifies economic returns by linking Global Fund grant delivery results with projections of the future costs of ARV therapy programs and of corresponding gains in patient survival and the economic value of life-years gained[1].

3. Two distinct approaches were used for the valuation of economic benefits. First, a components-based approach estimates the concrete monetary value of two specific economic benefits conferred by ARV therapy: increased labor productivity and averted cost of orphan care. The second, more theoretical approach captures economic benefits more broadly by estimating the intrinsic value of life-years gained, based on individuals' willingness to pay for mortality risk reductions, in different countries. In both approaches, net benefits are obtained by subtracting the annual costs of ARV therapy programs from the (gross) monetized value of their benefits.

4. Economic benefits are projected for the 3.5 million people expected to be on ARV therapy in 2011, through currently approved Global Fund-supported programs. Over the 11-year period from 1 January 2010 to 31 December 2020, the cumulative cost of ARV therapy programs for these patients is estimated at US$ 19.6 billion[2]. Our analysis suggests that over this period the economic benefits gained from live-years saved in these ARV therapy patients will exceed the cost of treatment. Using the "selected components" approach, the monetary benefit from increased labor productivity and orphan care together is expected to roughly offset the costs of ARV therapy. Over a range of assumptions reflecting uncertainty about the impact of HIV and ARV therapy on productivity, the benefits range from 79 percent to 115 percent of the ARV therapy program cost over the 11-year time period; in our base case estimate, this results in a net monetary benefit of US$ 662 million. Over 90 percent of these benefits are due to productivity gains of ARV therapy patients, with the remainder attributable to orphan care averted.

5. The wider returns on investment were quantified by valuing life-years gained based on studies of "willingness-to-pay". Estimating willingness to pay according to countries' *per capita* income, a median value per life-year gained of 1.37 times a country's *per capita* gross national income was assumed across Global Fund-supported countries. In this approach, the total monetary value of ARV therapy is more than twice the costs of delivering AIDS treatment over the 11-year period, with the net total benefit estimated at US$ 24 billion.

6. Further work needs to be done to strengthen the evidence base for this analysis, especially around (a) the labor productivity effects of ARV therapy; (b) the cost of delivering treatment in different programs and settings; (c) the medical care costs averted or postponed as a result of ARV therapy; and (d) the valuation of healthy life-years gained in low- and middle-income settings and specifically in programs supported by the Global Fund. Despite uncertainties around these parameters, the initial projections presented in this paper indicate that, at the global level, Global Fund-supported ARV therapy programs produce substantial monetary benefits and generate a positive return on investment.

[1] Economic analyses led by Results for Development Institute, building on cost and health impact projections by the Futures Institute.
[2] All estimated future costs and benefits are presented as real US$ 2009.

INTRODUCTION

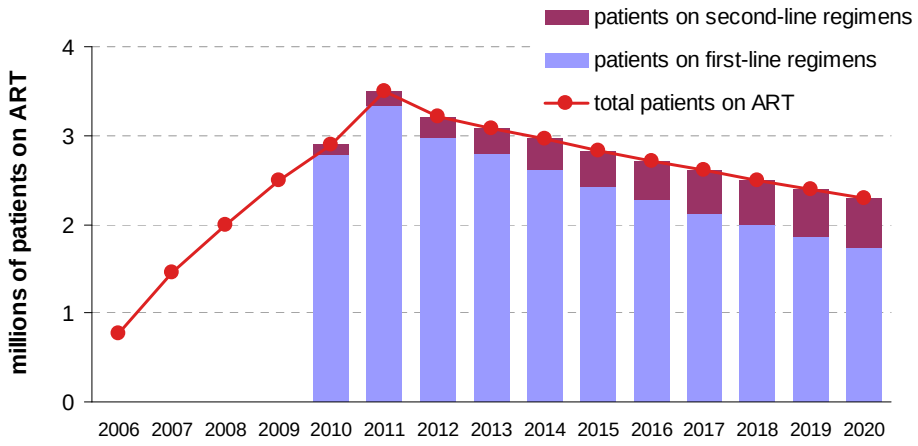
7. Since it was established in 2002, the Global Fund has become a major source of financial support to the scale-up of national responses to the three pandemics in low- and middle-income countries. As of December 2009, the Global Fund had approved HIV proposals totaling close to US$ 10.8 billion and disbursed a cumulative total of US$ 5.7 billion for HIV programs [1]. At the end of 2009, 2.5 million people in Global Fund-supported programs were receiving ARV therapy – an increase of 500,000 from the end of 2008. By the end of 2011, the number of people receiving ARV therapy is expected to reach 3.5 million, through currently approved grants through Round 9.

8. Assuming that these Global Fund-supported patients will continue to receive ARV therapy, model-based projections indicate that both the cost and the expected health impact will be substantial [2]. Continuing support for the 3.5 million persons expected to be on ARV therapy as of the end of 2011 will save an estimated 20.1 million (undiscounted) life-years, by keeping 2.2 million more people alive in 2020 than if these ARV therapy programs were discontinued in 2010. The (undiscounted) cost of delivering ARV therapy at this scale (which includes provision of second-line regimens to patients needing them) is estimated to be US$ 19.6 billion, cumulatively, over the 11-year period from 2010–2020 (Figure 1).

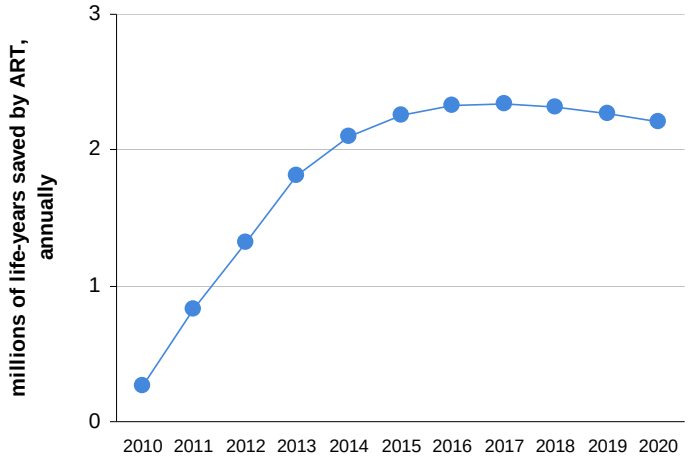
9. In this study, the monetary value of the benefits that could be generated between 2010 and 2020 through Global Fund–supported ongoing provision of ARV therapy to the people expected to be on ARV therapy by the end of 2011 is quantified. Building on the model of ARV therapy patient cohort survival developed by the Futures Institute, in Section 3 two key components of economic benefits produced by ARV therapy are modeled: (1) the expected productivity gains that accrue for ARV therapy patients returning to work; and (2) savings from reductions in the number of orphans and other vulnerable children needing care and support. These two types of benefits may be of special interest to governments and donors because, at the societal level, they represent the direct offsets to the costs of delivering ARV therapy. These are also benefits that could relatively easily be measured in terms of increased economic output or reduced public sector financial outlays, over the coming years of ongoing ARV therapy scale-up.

10. While these benefits are the most tangible return-on-investment that policy-makers may consider when evaluating the affordability and sustainability of ARV therapy programs in the short- to medium-term, they represent only a fraction of all benefits produced by ARV therapy. They do not include, among others: (1) the intrinsic value of longer life to the individual and their family; and (2) second-order economic impacts such as the lower future lifetime earnings of children who must miss school to care for, or replace the earnings of, a sick parent. In order to capture these additional benefits comprehensively, in Section 4 the total benefits of increased survival on ARV therapy are monetized by applying country-specific values per life-year gained derived from estimates of willingness-to-pay for mortality risk reductions. This second, more theoretical, approach provides a more complete estimate of the monetary value of the overall benefits that ARV therapy generates.

Figure 1: (a) Patients on ARV therapy in Global Fund-supported programs according to end-2009 grant results and 2010-2011 grant targets

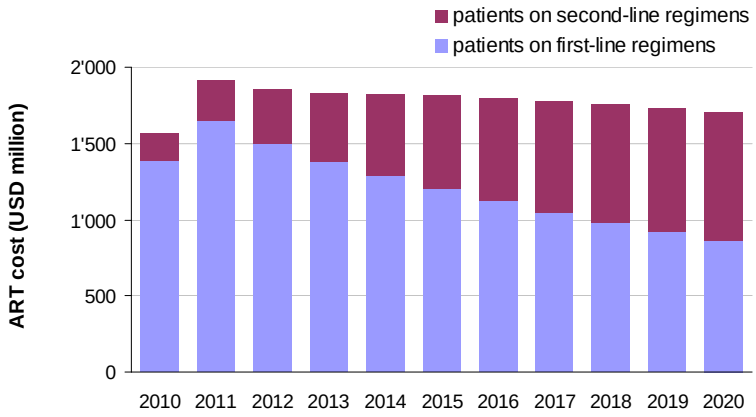


(b) Corresponding life-years saved, annually



Source: *Futures Institute* / Global Fund [2].

(c) ARV therapy program cost, annually



SELECTED BENEFIT COMPONENTS APPROACH

1. Methods

11. Productivity gains, orphan-years averted through ARV therapy and net monetary benefits were estimated based on existing projections of costs and life-years gained by ARV therapy over the period 2010 to 2020, as described elsewhere [2].

1.1 Labor productivity of patients on ARV therapy

12. Using the human capital approach to valuing productivity [3], the monetary value of incremental productivity was estimated, using for each country the increase in labor force participation due to ARV therapy, adjusting for unemployment. Expected earnings through increased productivity were computed using per capita income, adjusted for purchasing power parity[3] to allow for comparability across countries.

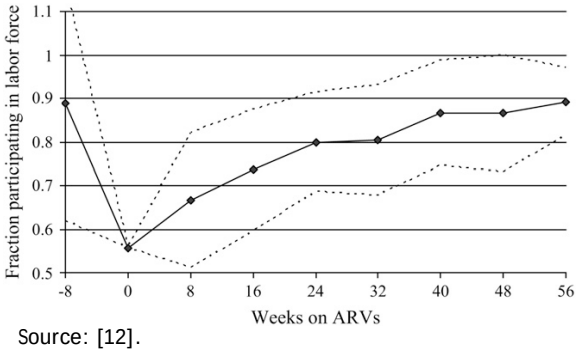
13. Table 1 summarizes empirical evidence on the impact of ARV therapy on work force participation, absenteeism, and productivity, based on recent literature reviews [4, 5]. Most studies look at productivity in a cohort of patients before and after initiating ARV therapy. In general, these studies have found a V-shaped pattern of economic productivity, with a sharp decline in productivity in the months leading up to treatment initiation (Figure 2). Within six months of beginning ARV therapy, patients experience sharp rises in labor productivity, both in terms of days worked per month and output per day worked.

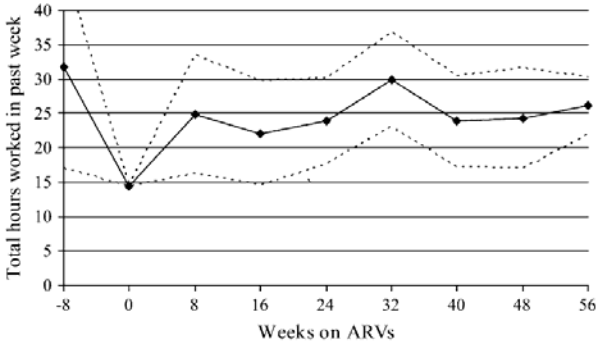
14. In most studies, surviving ARV therapy patients return to levels of productivity near to those of persons with unknown HIV status [6]. However, some studies have found less than complete restoration of productivity – such as in South Africa, where high rates of unemployment combined with stigma against people living with HIV are thought to limit the ability of ARV therapy patients to re-enter the work force [7]. While no studies have followed patients for the length of time modeled in this analysis, longitudinal studies following patients as far as 28-months post-ARV therapy initiation have not observed any fall-off in productivity restored by ARV therapy [7].

1.2 Labor productivity of patients without ARV therapy

15. The same studies also show that untreated patients who are in need of ARV therapy, if employed, are more frequently absent from work and are more likely to drop out of the labor force as their disease progresses (Table 1). The severe decline in health status and high level of hospitalization in patients in need of ARV therapy who are not accessing treatment [8-11] furthermore suggests that if "pre-ARV therapy" patients are left untreated, their level of health and corresponding labor productivity decline much further (see example in Figure 3, for mine workers in Botswana).

Figure 2. Work productivity of adult HIV patients before and after initiation of ARV therapy, Western Kenya





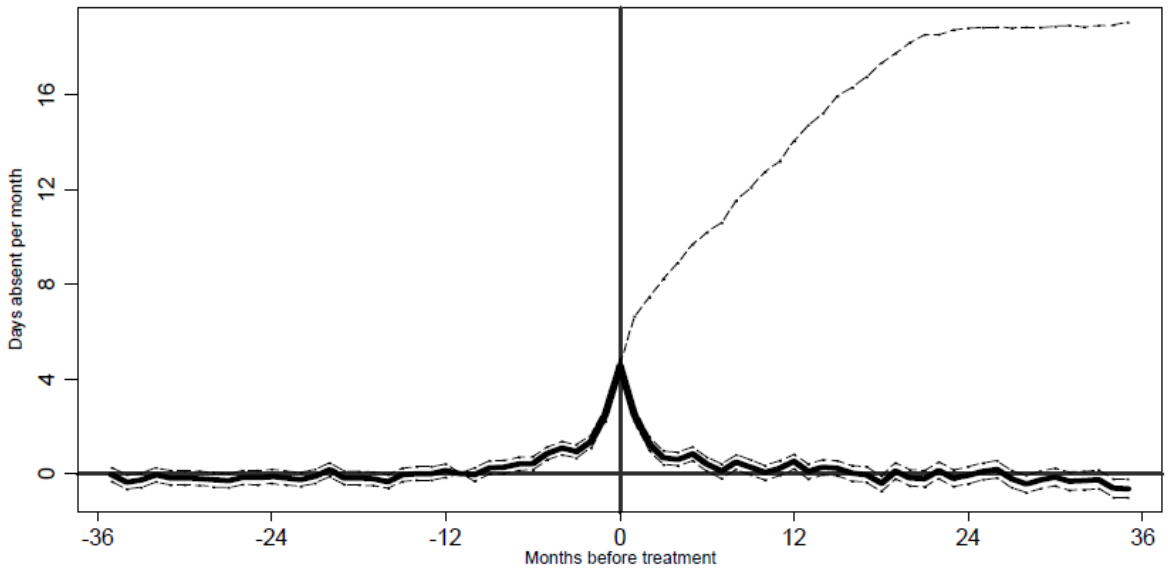
Source: [12].

[3] Monetary values adjusted for purchasing power in local markets are expressed in "international dollars". An international dollar has the same purchasing power as US$ 1 has in the U.S., and can buy the same amount of goods and services in any country.

Table 1. Labor force participation and productivity after ARV therapy initiation

Country	Summary of Findings
Labor force participation and employment	
Kenya [12]	Prospective study surveyed sample at multiple time points. Non-ARV group included to control for secular trends. Study looked at formal and informal sector work. Among patients who started ARV therapy within 100 days of baseline, labor force participation increased from 65 percent to 82 percent and hours worked per week increased from 20.3 at baseline to 28.2 within six months. Compared to a counterfactual of no ARV therapy, the authors estimate an increase in labor force participation of 85 percentage points, and hours worked increased 26 per week.
India [13]	Compared to pre-ARV therapy, labor force participation improved from 27 percent to 74 percent of ARV therapy patients at ten months after initiation.
South Africa [14]	Increase in labor force participation from 67 percent to 85 percent and employment from 42.3 percent to 52.9 percent, in 1 year after ARV therapy. High level of unemployment overall in economy limits gains for ARV therapy patients.
Cambodia [15]	Full-time employment increased from 49 percent to 96 percent within 1 year of starting ARV therapy.
India [16]	Increase in labor force participation by 26 percentage points. Increase of 14.5 weekly hours worked at six months post-ARV therapy initiation vs. pre-ARV therapy. Results sustained at 12 months post-initiation.
Absenteeism and output per work hour	
Botswana [17]	Year before initiation: absenteeism of enrolled workers increases sharply to a peak of five days/month in last month. First six months after initiation: absenteeism declines sharply. 4 years 7 months after initiation: no difference between enrolled workers and rest of workforce.
Kenya [6, 18]	Prospective study of tea plantation workers finds harvesting-days per month dropped 60 percent from reference group average as HIV progressed. After ARV therapy initiation, the decline was almost fully reversed by 12 months post-initiation. No reduction in output *per work day* compared to reference group was observed for men on ARV therapy, but a shift to non-harvesting tasks (lower output light duty work) for women persisted even after several months on ARV therapy. Women on treatment may remain 10 to 15 percent less productive than reference women, but there is no difference in productivity between men on treatment and reference group men.
Côte d'Ivoire [19]	Comparing 12 months prior to ARV therapy program with 24 months after ARV therapy program, large company found 94 percent reduction in HIV-related absenteeism.
South Africa [20]	Decrease in work absence from 7.5 days per month prior to ARV therapy initiation to 2.1 days by 12 months post-initiation.
Chile [21]	Worker absenteeism declined from 78 days/year at baseline to 52 days/year at 28 months post-ARV therapy-initiation.
South Africa [22]	Days absent due to health decreased from 3.1 per month pre-ARV therapy to 1.3 per month after being on ARV therapy three to six months.
Productivity in untreated adult HIV patients	
Kenya [23]	Untreated HIV patients had increased missed work days, reduced quantity of tea harvested on days worked, and 17.7 percent lower earnings in the year preceding AIDS-related termination of employment by workers on a tea plantation. Those in whom disease progressed to the point of being symptomatic (e.g. patients in the 3 to 12 months prior to initiating ARV therapy) work less than half as much as those without HIV or with early-stage HIV.

Figure 3. Absenteeism from work among HIV-infected miners not accessing ARV therapy in Botswana*



*Solid black line shows observed absenteeism over time around the time of ARV therapy initiation. Thin dashed line shows a predicted counterfactual (no ARV therapy) trajectory of abstenteeism. Source: [17].

16. Based on these data, in the base case it was assumed that if treatment was discontinued for the Global Fund-supported cohort, the productivity of these patients would, on average over their remaining lifetime, be about 20 percent of the productivity of the average person in their country. For those initiating ARV therapy, it was assumed that labor productivity is also 20 percent of country-average productivity, and that it would take six months after beginning treatment for their productivity to rise. From six months after ARV therapy initiation, it was assumed that productivity of these patients would attain 90 percent of the country-average productivity, until the year that treatment failed. In the last year of an ARV therapy patient's life, it was assumed that their productivity drops to the level of an untreated patient with active AIDS, i.e. 20 percent of country-average productivity. The value of housework in one's own home was not counted, since this is not included in standard definitions of labor force participation.

17. This set of assumptions regarding productivity with and without ARV therapy, summarized in Table 2, is similar to that used in a 2006 study conducted by the International Labour Organization [24].Given the uncertainties surrounding these "best available" estimates of productivity, sensitivity analysis was also performed, using a range of values for the assumed productivity of ARV therapy patients and non-treated individuals that were both higher and lower than base-case assumptions.

1.3 No discounting – no averted costs of medical care

18. The base case assumes no discounting of future costs or benefits over the 11-year time horizon. Therefore the analysis did not consider the effect of ARV therapy on postponing the costs of end-of-life care for HIV/AIDS patients as a category of benefit. Because ARV therapy postpones but does not avert death from AIDS, the costs of end-of-life care will occur later, and only with discounting will there be a net benefit as a result of medical care costs avoided in earlier years.

Table 2. Key assumptions on labor productivity of HIV/AIDS patients on ARV therapy

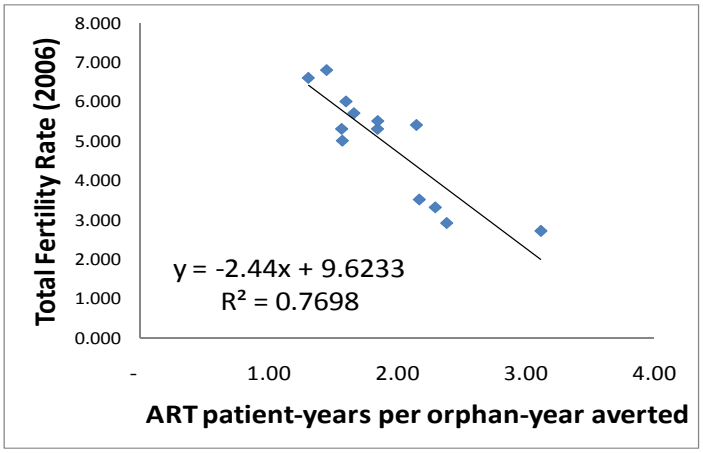
Parameter	Base Case	Sensitivity analysis
Labor productivity relative to country-average		
Untreated symptomatic HIV/AIDS cases	20%	0%, 40%
Patients established on ARV therapy	90%	75%, 100%
Value of full-time employment	*Per capita* Gross National Income, adjusted (yearly) for Purchasing Power Parity	N/A
Months after starting ARV therapy before productivity rebounds	6	3

1 4 ARV therapy reducing orphanhood

19. Orphan-years averted by ARV therapy were computed per adult life-year gained on ARV therapy, using the Spectrum AIDS Impact Model [25]. For each of the 14 countries that include the top ten Global Fund-supported ARV therapy countries and the top ten Global Fund-supported countries for support to orphans and other vulnerable children, the model was run to determine numbers of orphans averted by the ARV therapy program. These countries represent 69 percent of ARV therapy patients and 94 percent of all Global Fund-supported orphans. (Orphans were defined as children losing one or both parents.) Number of children orphaned each year was used to compute corresponding number of orphan-years, counting each orphan for the years remaining until the age of 18.

20. The difference in the number of orphan-years with and without ARV therapy was divided by the patient-years of ARV therapy to estimate an average number of orphan-years averted per patient-year of ARV therapy. Across the 14 modeled countries, between 0.32 and 0.76 orphan-years (average 0.5) are averted each year that a patient survives on ARV therapy. The number varies across countries because of country variations in fertility rates, infant mortality and the age distribution of HIV-positive adults. For other Global Fund-supported countries, the findings from the 14 modeled countries was extrapolated by linear interpolation based on country-specific fertility rate (Figure 4).

Figure 4. Correlation between total fertility rate and person-years of ARV therapy required to avert 1 orphan-year, across 14 countries with Global Fund-supported ARV therapy programs



1.5 (Averted) costs of orphan care

21. The social and economic effects on children orphaned by deaths of parents due to AIDS include poorer nutrition, poorer education, increased vulnerability to child labor and disease, and lower future earnings once grown-up [26, 27]. In this study, instead of quantifying all these effects throughout the lifespan of orphans, the focus was on the direct costs of providing orphan care and support through social mitigation programs. These costs would be saved by donors and governments if ARV therapy programs prevent children from becoming orphans. Where orphan-care programs have not been scaled-up, the impact of ARV therapy may not directly translate into savings in the budgets of orphan-care programs. Nevertheless, the benefits calculated can be considered to represent a lower bound of the economic value of reducing orphanhood, because the economic cost of unmitigated negative outcomes for orphans (i.e. negative impacts not reversed by social programs) is probably larger than the cost of mitigation programs.

22. The base case assumptions are summarized in Table 3. Orphan support was estimated to cost a mean US$ 224 per child-year, based on cost data collected from 300 orphan care service providers at 7,400 sites in 22 African countries [25]. This estimate included a downward adjustment from observed costs for expected economies of scale expected during ongoing program scale-up.

23. It was assumed that only orphans in families below the country's poverty line would require support services, as in wealthier families the care of orphans might be absorbed without the assistance of orphan-care programs. In sensitivity analysis, as an alternative the cost of orphan was applied to all orphans, consistent with the interpretation that this cost is a lower bound on the overall economic effects of orphanhood, or a proxy estimate of the cost of orphan support programs combined with families' private expenses for orphans.

Table 3. Key assumptions on economic effects of ARV therapy through reduced orphanhood

Parameter	Base Case Value
Orphan-years averted per patient-year of ARV therapy	Country-specific, varying **from 0.32 to 0.76 (average 0.5),** computed with *Spectrum* [28] among the 14 countries with largest numbers of Global Fund-supported ARV therapy and support to orphans and other vulnerable children. Other countries extrapolated adjusting for total fertility rate.
Fraction of orphans needing care and support	Equal to fraction of full population below nationally-defined poverty line, which ranged **between 25 percent and 75 percent** (average across Global Fund-supported ARV therapy patients: **46 percent** in the 14 countries with largest numbers of Global Fund-supported ARV therapy and support to orphans and other vulnerable children.(In sensitivity analysis, the assumption as alternative is that all orphans need care).
Cost of care to orphans and other vulnerable children per orphan-year	**US$ 224**, based on data from 300 nongovernmental organizations, 7,400 sites in sub-Saharan Africa, adjusted for expected economies of scale during program scale-up [25].

2. Results

2.1 Benefits from labor productivity

24. Increased labor productivity of ARV therapy patients is projected at US$ 1.9 billion in 2012 alone, with a similar benefit in subsequent years (Figure 5). Annual gains from productivity follow the trend in life-years gained from ARV therapy (Figure 1b). As the number of life-years gained stabilizes after 2015, the annual productivity gains also level off. Over the 11-year time horizon, the total productivity gain equals US$ 19.1 billion.

2.2 Benefits through reduced orphan care

25. The value of orphan care needs averted increases over time (Figure 5) in direct proportion to the number of incremental life-years added each year for patients on ARV therapy (Figure 1b). Over the 11-years, the cumulative benefit is estimated at US$ 1.1 billion.

2.3 Net monetary benefits

26. In the first year of treatment, incremental productivity gains do not fully offset the cost of ARV therapy because new patients require six months to return to high levels of productivity, and because in the "no treatment" counterfactual most patients would still be alive. Therefore, in 2010 and 2011 the net benefits of ARV therapy are below zero (Figure 6). In subsequent years, as life-years gained by ARV therapy accumulate for the 2011 cohort, net benefits steeply increase, to a peak in 2013—2014 at around US$ 188 million. As patients increasingly experience treatment failure over the next 5 years, net benefits then gradually decrease again.

27. As a result of this pattern, cumulatively over 11 years, the net benefit amounts to US$ 662 million. The overall benefit from productivity gains and averted orphan care amounts to US$ 20.2 billion, compared to the 11-year ARV therapy program cost of US$ 19.6 billion.

Figure 5. Annual monetary benefit from ARV therapy through incremental labor productivity of patients and orphan care averted, for Global Fund-supported patients as of 2011

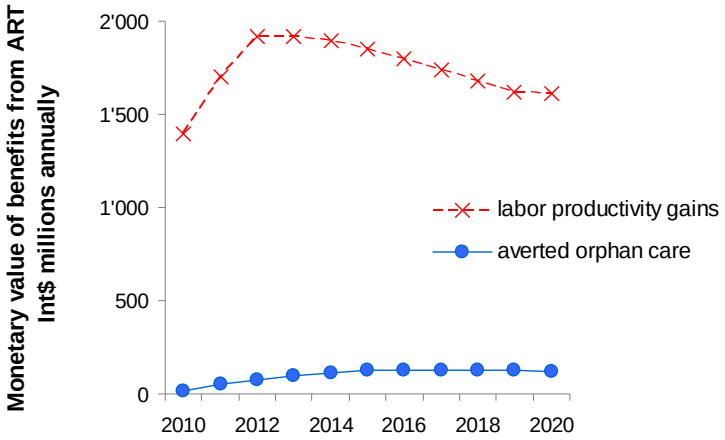
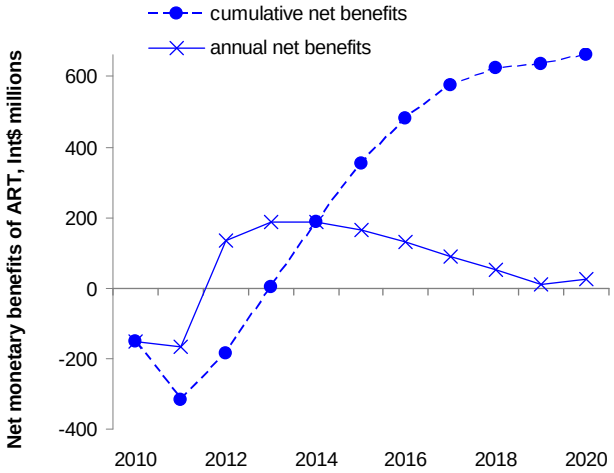


Figure 6. *Net* **monetary benefits of ARV therapy, for patients on ARV therapy in Global Fund-supported programs at the end of 2011**: (subtracting ARV therapy program cost from benefits due to increased productivity and averted orphan care).



3. Sensitivity Analysis

3.1 Productivity levels of patients living with HIV or AIDS, with and without ARV therapy

28. Available data leave significant uncertainty about the productivity of patients living with HIV or AIDS, with and without ARV therapy, especially beyond the first two years on treatment. Therefore, a range of productivity levels for patients responding to treatment was considered, between 75 percent and 100 percent of country-specific average productivity and untreated patients between 0 percent and 40 percent of country-specific average productivity.

29. In the base case, net monetary benefits are positive but small compared to the initial and overall cost of the ARV therapy programs. Of eight combinations of alternative productivity assumptions (Table 4), the case of 100 percent productivity of ARV therapy patients and 0 percent productivity of untreated patients (upper left of Table 4) is unlikely to be observed, but is presented to demonstrate the upper bound of possible net monetary benefit. In the four combinations more pessimistic than the base case, where productivity is only 75 percent for ARV therapy patients and 20 percent or higher for untreated patients, the cumulative net monetary benefits are negative, i.e. benefits do not fully compensate for program costs.

30. However, even in the more pessimistic cases considered, productivity gains and averted orphan care offset at least three-quarters of the ARV therapy program cost (Table 5): across all plausible combinations of productivity assumptions, the benefits over the 11-year evaluation period ranged from 79 percent to 115 percent of the ARV therapy program cost.

31. Net benefits are more sensitive to the productivity level of patients responding to ARV therapy than to the productivity level of untreated patients. This is because patients on ARV therapy survive longer than untreated patients, so their productivity accumulates over a greater number of years.

Table 4. Net monetary benefits depending on the assumed productivity levels of patients living with HIV or AIDS, cumulative over 2010—2020

Productivity of untreated patient	Productivity of patient responding to treatment		
	100%	**90%**	75%
0%	Not considered plausible		-US$ 1,419
20%	US$ 2,936	**US$ 662**	-US$ 2,749
40%	US$ 1,606	-US$ 668	-US$ 4,078

Note: The base-case estimate is indicated in bold.

Table 5. Benefits as a percentage of ARV therapy program costs, cumulative from 2010 to 2020

Productivity of untreated patient		Productivity of patient responding to treatment		
		100%	**90%**	75%
0%	Benefit	Not considered plausible		US$ 18,159
	Benefit/cost			**93%**
20%	Benefit	US$ 22,514	US$ 20,240	US$ 16,829
	Benefit/cost	**115%**	**103%**	**86%**
40%	Benefit	US$ 21,184	US$ 18,911	US$ 15,500
	Benefit/cost	**108%**	**97%**	**79%**

3.2 Savings from orphan care: all orphans instead of orphans below poverty line

32. In the base case only the cost implications of averting orphans whose families were below the nationally defined poverty line was considered. In a sensitivity analysis considering all orphans (averted) in the monetary valuation, cumulative net benefits are substantially larger: over US$ 1.9 billion compared to the base-case estimate of US$ 662 million..

4. Full benefits: the Willingness-to-Pay approach

33. The benefits monetized using the "selected components" approach above are the most tangible return-on-investment policy-makers may consider when evaluating the economic impact of ARV therapy programs in the short- to medium-term. But, as mentioned earlier, this approach captures only a fraction of all benefits produced by ARV therapy. Therefore, in this section, the total benefits of increased survival on ARV therapy are monetized by applying country-specific valuations of a life-year gained that are derived from studies of willingness to pay to avoid mortality risks.

34. This second approach to assessing the wider returns has additional limitations, as it does not specifically derive from empirical data around the economic effects of ARV therapy but instead uses more theoretical assumptions on the overall monetary value of life-years gained by health interventions, in relation to country gross national income.

4.1 Methods

35. The common metric derived from studies of willingness-to-pay to avoid mortality risks is the value of a statistical life (VSL) [29]. For example, if a person is willing to accept US$ 500 per year in wages to work in a job that has a 1 in 10,000 higher annual risk of mortality, then VSL is 500/0.0001 = US$ 5 million. Accordingly, an intervention that reduces mortality risk by 1 per 10,000 people would be "worth it" if it cost less than US$ 5 million.

36. In developed countries, VSLs have been found to range between US$ 3 million and US$ 7 million, for respondents with an average remaining life expectancy of around 40 years [30]. Compared across countries, among developed countries the VSL is typically between 75 to 180 times the countries' Gross National Income per capita [31]. This range holds for middle-income countries as well, although most middle-income countries fall in the lower end of the range [32]. There are, however, no studies of VSL in low-income countries, and probably the VSL is much lower in those countries because of both lower life expectancy and lower income. The U.S.-based VSL estimate of US$ 5 million was transferred to the countries of the Global Fund portfolio assuming an average 25 years of life expectancy for adult workers, and assuming that every two-fold lower Gross National Income would result in a three-fold lower VSL (i.e. income elasticity of 1.5 [33, 34]). For some countries this extrapolation resulted in a VSL lower than the present value of future earnings, which is implausible, and those VSL estimates were replaced by the present value of future earnings.

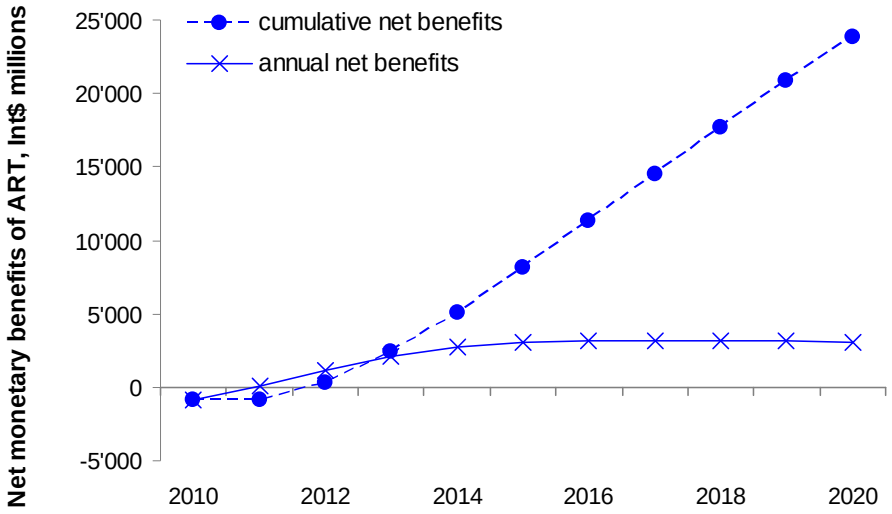
37. The resulting country-specific VSL estimates were then translated into estimates of the Statistical Value per Life-Year (VSLY), by dividing by the average 25-year life expectancy. This resulted in VSLY estimates of between 1.0 and 3.6 times per capita Gross National Income across countries, with a population-weighted average of 1.37.

38. To compute the net monetary benefits, ARV therapy program costs were subtracted from the value of life-years gained. The value of delayed direct medical care costs for AIDS care or the value of orphan care costs averted were not included, since the valuation of life-years gained is assumed to include the value of averting these costs.

4.2 Results

39. Figure 7 shows the monetary benefits based on the "willingness-to-pay" approach. Annual benefits are considerably larger than the projected costs of AIDS treatment, from 2012 onwards (Figure 7). Cumulative net benefits become positive in 2012. Over the full 11-year horizon, the cumulative net benefit is US$ 24 billion.

Figure 7. *Net* **monetary benefits of ARV therapy using the "willingness-to-pay" approach to (comprehensively) valuing life-years gained**



DISCUSSION

1. Overall Findings

40. This study presents initial findings of a new approach to modeling the return-on-investment in Global Fund ARV therapy programs, made possible by the linkage of Global Fund grant delivery results with model projections of the cost and health impact of supported ARV therapy programs. The findings included that Global Fund-supported ART programs generate important monetary benefits. Over the 11-year period evaluated here, these direct benefits are of the same order of magnitude as or larger than the ARV therapy program cost. In other words, investments in Global Fund-supported AIDS treatment "buy" direct gains that have a value that exceed the future costs of the treatment programs themselves.

41. Using the "selected components" approach, the monetary benefit from increased labor productivity and orphan care together is estimated to roughly offset the costs of ARV therapy by the end of 2020. Over a range of assumptions reflecting uncertainty about the impact of HIV and ARV therapy on productivity, the cumulative benefits range from 79 percent to 115 percent of the ARV therapy program cost over the 11-year time period; in the best-case estimate, this results in a positive net monetary benefit of US$ 662 million.

42. Over 90 percent of these benefits are due to productivity gains of ARV therapy patients, with the remainder attributable to orphan care averted. These benefits do not include the discounted net savings from postponing the onset of spending on care for AIDS-related illness. Moreover, the estimates only consider the net benefits that accrue through 2020. As the ratio of benefits to costs increases over a patient's life on treatment, a small additional monetary benefit will accrue from continuing support of the patients that survive until after 2020.

43. Estimating the wider returns involves additional uncertainties, in particular in valuing life-years gained across countries. Valuing life-years saved at 1.37 times countries' per capita Gross National Income (as a population-weighted average across Global Fund-supported countries), the total monetary value of ARV therapy is more than twice the program costs over the 11-year period, with a corresponding net benefit of US$ 24 billion as total over 2010 to 2020. There is, however, considerable uncertainty around the best life-year valuation relative to country income. The estimates of VSLY extrapolated from willingness-to-pay studies in high-income countries are in line with norms used by national health programs in Australia and the United Kingdom.

44. Neither the "selected components" approach nor the "willingness-to-pay" approach take into account any benefits beyond those accruing directly to ARV therapy patients and their families. Additional, society-level benefits, especially if ARV therapy is included in a package combined with HIV prevention, may include reduced stress and feelings of loss and hopelessness that erode the social fabric, foster political instability, and further slow economic growth in communities experiencing large numbers of AIDS illnesses and deaths.

45. These societal benefits are difficult to quantify, but should nevertheless be recognized as additional benefits obtained through a successful scale-up of ARV therapy in high-prevalence settings.

2. Limitations

46. These results should be seen in the light of important limitations and uncertainties about key assumptions used in the projections, related to (a) the labor productivity effects of ARV therapy; (b) the cost of delivering treatment in different programs and settings; (c) the medical care costs averted or postponed as a result of ARV therapy; and (d) the valuation of healthy life-years gained in low and middle income settings.

47. For labor productivity effects of ARV therapy, the most significant limitation is the assumption that, if not for the effects of their disease, the HIV-positive sub-population in a country would always be 90 percent as productive as the average person in the country. This may not be the case in settings where HIV is concentrated in marginalized subpopulations who typically have a lower average income. Also, in settings with high levels of unemployment there is a ready pool of replacement workers, particularly for unskilled jobs. In these situations, AIDS-related mortality may have a more limited impact on total economic output than would be apparent from productivity levels of the individual patient. The size of the resulting overestimation of economic benefit is likely to be largest for higher-income countries with large income inequality, and for settings with concentrated HIV epidemics.

48. Productivity gains were based on a few existing studies that sample a total of a few thousand patients in fewer than ten countries. These studies were remarkably consistent in demonstrating sharp declines in productivity in symptomatic patients not accessing treatment, followed by rapid and sustained restoration of physical function and productivity following ARV therapy initiation. But no study has observed the productivity of ARV therapy patients over later years after ARV therapy initiation, whereas these models assume that the initial productivity gain is maintained throughout the patients' entire lifespan on ARV therapy. Given this uncertainty, at present it is not possible to estimate the precise net benefits resulting from increased productivity, although under all combinations of assumptions, productivity gains would compensate for at least 75 percent of ARV therapy program costs over the 11-year evaluation horizon.

49. Besides productivity, also the costs of ARV therapy programs are known only imprecisely, without a full understanding of the variations between different settings and how they may evolve over the coming decade, given developments in ARV drug prices, ARV regimens used in countries and per-patient delivery costs as programs mature and scale up. The presented cost estimates were based on country-reported ARV prices, but for other key cost components such as medical and program staff, laboratory, infrastructure and equipment and overheads, only a few countries have empirical expenditure data [1, 2, 5].

3. Conclusion

50. In conclusion, the findings in this paper should be taken as preliminary evidence, to be substantiated as empirical evidence on costs and economic effects of ARV therapy develops further. Despite the limitations, the projections made suggest that, at the global level, Global Fund-supported ARV therapy programs produce substantial monetary benefits and are likely to generate a positive economic return on investment.

REFERENCES

1. The Global Fund to Fight AIDS Tuberculosis and Malaria. The Global Fund Results report 2010: innovation and impact. Geneva, 2010: <http://www.theglobalfund.org/en/media/?lang=en>
2. The Global Fund to Fight AIDS Tuberculosis and Malaria. Financial and health impacts of continued support to the three diseases: long-term estimates. Geneva, 2010:
3. Lofland JH, Locklear JC and Frick KD. Different approaches to valuing the lost productivity of patients with migraine. Pharmacoeconomics 2001;19:917-25
4. Beard J, Feeley F and Rosen S. Economic and quality of life outcomes of antiretroviral therapy for HIV/AIDS in developing countries: a systematic literature review. AIDS Care 2009;21:1343-56
5. Galarraga O, Wirtz VJ and Medina-Lara A. Unit Costs for Antiretroviral Treatment, Prevention of Mother to Child Transmission, and HIV Testing and Counseling: A Systematic Review. Cuernavaca: Mexico Institute of Public Health (INSP) / Consortium for Research on HIV/AIDS and Tuberculosis (CISIDAT), for the Global Fund, Program Effectiveness Team 2009:
6. Larson BA, Fox MP, Rosen S, et al. Early effects of antiretroviral therapy on work performance: preliminary results from a cohort study of Kenyan agricultural workers. AIDS 2008;22:421-5
7. Coetzee C. The impact of highly active antiretroviral treatment (HAART) on employment in Khayelitsha. South African J of Economics 2008;76:S76-S85
8. Cleary SM, McIntyre D and Boulle AM. The cost-effectiveness of antiretroviral treatment in Khayelitsha, South Africa--a primary data analysis. Cost Eff Resour Alloc 2006;4:20
9. Harling G, Wood R. The evolving cost of HIV in South Africa: changes in health care cost with duration on antiretroviral therapy for public sector patients. J Acquir Immune Defic Syndr 2007;45:348-54
10. Bikilla AD, Jerene D, Robberstad B and Lindtjorn B. Cost estimates of HIV care and treatment with and without anti-retroviral therapy at Arba Minch Hospital in southern Ethiopia. Cost Eff Resour Alloc 2009;7:6
11. Badri M, Maartens G, Mandalia S, et al. Cost-effectiveness of highly active antiretroviral therapy in South Africa. PLoS Med 2006;3:e4
12. Thirumurthy H, Graff Zivin J and Goldstein M. The economic impact of AIDS treatment: labor supply in Western Kenya. J Hum Resources 2008;43:511-552
13. Ajithkumar K, Iype T, Arun KJ, Ajitha BK, Aveenlal KP and Antony TP. Impact of antiretroviral therapy on vocational rehabilitation. AIDS Care 2007;19:1310-2
14. Coetzee D, Boulle A, Hildebrand K, Asselman V, Van Cutsem G and Goemaere E. Promoting adherence to antiretroviral therapy: the experience from a primary care setting in Khayelitsha, South Africa. Aids 2004;18 Suppl 3:S27-31
15. Morineau G, Vun MC, Barennes H, et al. Survival and quality of life among HIV-positive people on antiretroviral therapy in Cambodia. AIDS Patient Care STDS 2009;23:669-77
16. Thirumurthy H, Saravanan R, Srinivas G, Jafri A, Sreevidya J and Sahu S. The impact of antiretroviral therapy on socioeconomic outcomes of HIV-infected patients in tamil nadu family care continuum program, India. Paper presented at the XVII International AIDS Conference. Mexico City, Mexico. In: XVII International AIDS conference. Mexico city, 2008
17. Habyarimana J, Mbakile B and Pop-Leeches C. HIV/AIDS, ARV treatment and worker absenteeism: evidence from a large African firm. Vol. April, 2007: http://ipl.econ.duke.edu/bread/papers/0704conf/bread0704_habyarimana_mbakile_popeleches.pdf
18. Larson BA, Fox MP, Rosen S, et al. Do the socioeconomic impacts of antiretroviral therapy vary by gender? A longitudinal study of Kenyan agricultural worker employment outcomes. BMC Public Health 2009;9:240
19. Eholie SP, Nolan M. Antiretroviral treatment can be cost-saving for industry and life-saving for workers: a case study from Cote d'Ivoire's private sector. In: Moatti JP, T. Barnett, B. Coriat, Y. Souteyrand, J. Dumoulin, & Y.A. Flori, ed. Economics of AIDS and access to HIV/AIDS care in developing countries: issues and challenges. Paris, France: Agence Nationale de Recherches sur le Sida, 2003:329-346
20. Muirhead D, Kumaranayake L, Hongoro C, Charalambous S, Grant A and Fielding K. Health care costs, savings and productivity benefits resulting from a large employer sponsored ART program in South Africa. In: XVI International AIDS Conference. Toronto, Canada, 2006

21. Sgombich X, Bahamondes L and Cid C. Quality of life in work, absenteeism and HAART in workers living with HIV. In: XVI International AIDS Conference. Toronto, Canada, 2006
22. Rosen S, Ketlhapile M, Sanne I and Desilva MB. Differences in normal activities, job performance and symptom prevalence between patients not yet on antiretroviral therapy and patients initiating therapy in South Africa. AIDS 2008;22 Suppl 1:S131-9
23. Fox MP, Rosen S, MacLeod WB, et al. The impact of HIV/AIDS on labour productivity in Kenya. Trop Med Int Health 2004;9:318-24
24. International Labour Office, The ILO programme on HIV/AIDS and work. HIV/AIDS and work: global estimates, impact on children and youth, and response, 2006: http://www.ilo.org/public/english/protection/trav/aids/publ/global_est06/global_estimates_report06.pdf
25. Stover J, Bollinger L, Walker N and Monasch R. Resource needs to support orphans and vulnerable children in sub-Saharan Africa. Health Policy Plan 2007;22:21-7
26. Beegle K, De Weerdt J and Dercon S. Orphanhood and the long-run impact on children: Center for the Studies of African Economics, 2007: http://www.csae.ox.ac.uk/workingpapers/pdfs/2007-08text.pdf
27. Pridmore P. Access to conventional schooling for children and young people affected by HIV and AIDS in sub-Saharan Africa: a cross-national review of recent research evidence: SOPHIE 2008:
28. Stover J, Johnson P, Zaba B, Zwahlen M, Dabis F and Ekpini RE. The Spectrum projection package: improvements in estimating mortality, ART needs, PMTCT impact and uncertainty bounds. Sex Transm Infect 2008;84 Suppl 1:i24-i30
29. Nordhaus WD. The Health of Nations: The Contribution of Improved Health to Living Standards. In: Toppel KMaR, ed. Measuring the Gains from Medical Research. Chicago: University of Chicago Press, 2003:9-40
30. Kenkel D. Using estimates of the value of a statistical life in evaluating regulatory effects.
31. Jones-Lee MW. Safety and the savings of life: The economics of safety and physical risk. In: Glaister RLaS, ed. Cost-Benefit Analysis. Cambridge: Cambridge Press 1994:290-318
32. Viscusi WK, Aldy JE. The value of a statistical life: a critical review of market estimates from around the world. J Risk and Uncertainty 2003;27:5-76
33. Hammitt JK, Ibarraran ME. The economic value of fatal and non-fatal occupational risks in Mexico City using actuarial- and perceived-risk estimates. Health Econ 2006;15:1329-35
34. Costa DL, Kahn ME. Changes in the value of life, 1940-1980. J Risk and Uncertainty 2004;23:385-396

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