Optimizing Investments in the Kyrgyz Republic's HIV Response

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ACKNOWLEDGMENTS

The HIV allocative efficiency (AE) program, of which this study is part, is managed by the World Bank and supported by the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund), the United Nations Program on HIV/AIDS (UNAIDS), and the United Nations Development Programme (UNDP). The Steering Committee of the program—comprising Feng Zhao (Chair and World Bank Task Team Leader), Christoph Hamelmann (UNDP), Manoela Manova (UNAIDS), Emiko Masaki (World Bank), and Shufang Zhang (Global Fund)—provided overall guidance to the country studies. The four agencies and the United States Agency for International Development (USAID)/President's Emergency Plan for AIDS Relief (PEPFAR) cosponsored the various study activities.

The core analysis and report-writing team comprised Venera Maitieva (Ministry of Health, The Kyrgyz Republic), Liutsiia Ianbukhtina and Talgat Mambetov (National AIDS Center); Larisa Bashmakova and Meerim Sarybaeva (both UNAIDS); Predrag Đurić (UNDP); Andrew Shattock (UNSW); and Clemens Benedikt, Emiko Masaki, and Michael Obst, (World Bank). Substantial technical inputs also were provided by Dinara Soorombaeva (National Statistic Committee of the Kyrgyz Republic); Aida Abarbekova and Meerim Kazizova (Ministry of Finance, Kyrgyz Republic); Sandra Irbe, David Kokiashvili Nino Mdivani, and Shufang Zhang (Global Fund); Roman Hailevich, Manoela Manova and Otilia Scutelniciuc (UNAIDS); Christoph Hamelmann and John Macauley (UNDP); Robyn Stuart, Cliff Kerr, and David P. Wilson (UNSW); Rajeev Patel (USAID); Son Nam Nguyen (previous World Bank Task Team Leader) and Marelize Görgens (World Bank).

The Optima model applied in this study was developed by the University of New South Wales (UNSW) and the World Bank. Data collection for the Kyrgyz Republic was carried out by national consultants and facilitated by UNAIDS and the UNDP. Michael Borowitz, Nicolas Cantau (Global Fund), David Wilson (World Bank), Christoph Hamelmann (UNDP), and Jean-Elie Malkin and Vinay P. Saldanha (UNAIDS) conceptualized this Regional initiative on HIV allocative efficiency.

The authors also would like to thank all additional stakeholders and colleagues who provided insights and support. Alicia Hetzner edited the report.

ABBREVIATIONS

AE	allocative efficiency
AIDS	acquired immune deficiency syndrome
ART	antiretroviral therapy
ARV	antiretroviral drug
BALLSD	Bayesian adaptive locally linear stochastic descent
BCC	behavior change communication
CD4 cell	T–lymphocyte cell bearing CD4 receptor
CRS	creditor reporting system (OECD)
DALY	disability-adjusted life year
ECA	Europe and Central Asia
FSW	female sex worker
GARPR	Global AIDS Response Progress Report
GBD	global burden of disease
GDP	gross domestic product
GHHE	general government health expenditure
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
HCV	hepatitis C virus
HIV	human immunodeficiency virus
HTC	HIV testing and counselling
IBBS	integrated bio-behavioral surveillance
IMF	International Monetary Fund
LR	lower respiratory infection
INSERM	l'Institut national de la santé et de la recherche médicale (French Institute of Health and Medical Research)
MDG	Millennium Development Goal
MSM	men who have sex with men
MTCT	mother-to-child-transmission
NASA	National AIDS Spending Assessment
NHA	national health accounts
NSP	needle and syringe exchange program
NTD	neglected tropical disease
OECD	Organisation for Economic Co-operation and Development
OST	opioid substitution therapy
PEPFAR	President's Emergency Plan for AIDS Relief (U.S.)
PLHIV	people living with HIV
PMTCT	prevention of mother-to-child transmission
PWID	people who inject drugs
SDG	Sustainable Development Goal
STI	sexually transmitted infections
THE	total health expenditure
UNAIDS	Joint United Nations Program on HIV/AIDS
UNDP	United Nations Development Programme
UNGASS	United Nations General Assembly
UNSW	University of New South Wales

USAID	United States Agency for International Development
US$	United States dollar
WEO	World Economic Outlook (IMF)
WHO	World Health Organization
YLL	years of life lost

KEY MESSAGES

To accelerate progress toward achieving Kyrgyz Republic's national HIV targets, the effectiveness of the HIV response could be enhanced through four measures:

1. The **coverage of ART should be increased substantially and investment in ART increased approximately four-fold** because fully achieving national targets will require an increase from 13 percent of PLHIV covered in 2013 to 79 percent covered in 2020.
2. **Coverage of programs for PWID needs to be further increased,** needle-syringe programs (NSP) further expanded using HIV resources, and opioid substitution therapy (OST) expanded with cofinancing from other sectors.
3. Programs for **FSW and PMTCT** need to be sustained by at least approximately current coverage, and **MSM programs** need to be scaled up. Considering unit costs from other countries, reducing unit cost in these programs without compromising quality should be possible and is necessary for these programs to be cost effective.
4. **Additional technical efficiency analysis is required** to review the 56 percent of HIV spending going into management and other costs. These costs could not be included in the optimization analysis because their impact on incidence and deaths is indirect or not quantifiable.

Optimized allocation of current resources (US$12.6 million) would avert 28 percent of new infections and 53 percent of deaths over 2015–20. Optimized allocation to achieve national targets (with reduced management cost (US$16 million) would avert 65 percent of new infections and 63 percent of deaths, translating to 4,200 new infections and 2,300 deaths averted between 2015 and 2020**.**

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EXECUTIVE SUMMARY

An HIV allocative efficiency (AE) analysis was conducted to inform strategic investment in the Kyrgyz Republic's HIV response.

The Kyrgyz Republic's HIV epidemic is transitioning **from an early concentrated epidemic among people who inject drugs (PWID) into an advanced concentrated HIV epidemic**[1] **with continued transmission among PWID, but an increasing share of sexual transmission** to female partners of PWID and among men who have sex with men (MSM). The Optima model projects that, with current spending, the estimated 1,000 annual new infections in 2014 will increase to 1,100, and estimated deaths from 400 in 2014 to 600 deaths per year on average, over 2015–20. The total number of people living with HIV (PLHIV) is projected to increase from 8,400 in 2014 to 10,200 by 2020.

Optimizing allocations of the level of resources available in 2013 would substantially reduce new HIV infections by 28 percent and deaths by 53 percent by 2020. Optimization analysis suggests that this additional impact would be achieved primarily by **reallocating resources to 2 program areas: a 300 percent increase in investment in antiretroviral therapy (ART) and a moderate increase in coverage of prevention programs for PWID, particularly needle-exchange programs.** Nevertheless, despite the large efficiency gains through reallocations, the national targets to reduce both deaths and new infections by 50 percent by 2020 cannot be fully achieved with current resources.

The top priority in the Kyrgyz Republic's HIV response is to substantially increase the allocation to, and coverage of, ART. In 2013, only 7 percent of the total national HIV spending was allocated to ART, covering 13 percent of the total estimated PLHIV. With optimized allocations to fully achieve national targets, investment in ART would quadruple––from US$0.9 million to US$3.7 million––accompanied by increased investment in HTC from US$0.8 million to US$1.3 million. This level of spending would cover 6,700 PLHIV on ART, which translates to coverage of over 75 percent of all PLHIV and averting 2,300 deaths over 2015–20.

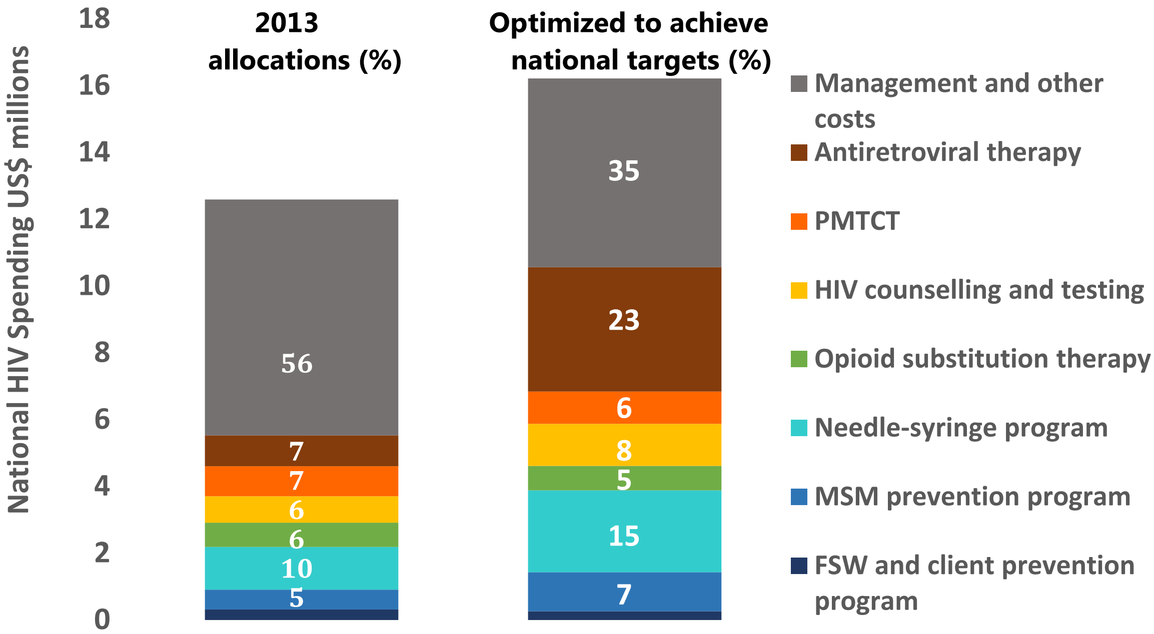
The second priority in the Kyrgyz Republic's HIV epidemic is to sustain and expand coverage of programs for PWID. Although the share of new infections due to needle-sharing has declined to less than 50 percent of all infections, programs for this group remain critical due to the large potential for epidemic growth among PWID in the absence of programs.

According to the limited data available, **HIV transmission among MSM is a small, but also the fastest growing, segment of the Kyrgyz Republic's HIV epidemic**. Focused, technically

[1] "Advanced concentrated HIV epidemic" here describes an epidemic in which HIV transmission remains related to key populations but in which shifts in the mode of transmission within key populations have occurred. In several countries of the Eastern Europe and Central Asia Region (ECA), initially, the largest mode of HIV transmission among PWID was needle sharing. More recently, the proportion of sexual transmission has grown. However, because sexual transmission remains concentrated among key populations and their sexual partners, these epidemics are not generalized.

efficient programs for MSM should expand their coverage to achieve national targets. Although female sex workers (FSW) and their clients contribute to less 5 percent of new infections in the Kyrgyz Republic, FSW remain a group that should continue to be reached. To fully achieve the target of reducing sexual transmission by 50 percent, programs for FSW would need to be sustained at current levels of investment but at a reduced unit cost. Because the national strategy includes an exclusive MTCT target, PMTCT remains part of the optimized mix to achieve national targets. **Allocations to achieve national targets** are defined as allocations to reduce incidence and deaths by 50 percent by 2020.

Figure 1.1 Optimized allocation of HIV funding to achieve national targets by 2020 (US$ million)



Achieving national targets in the Kyrgyz Republic would avert 2,300 deaths and 4,200 new infections by 2020. The amount needed to achieve these results depends heavily on the critical choices that the Kyrgyz Republic needs to make. With business as usual (current allocations, current unit costs), the cost will be US$43 million. The amount to achieve national targets with optimized allocations is US$24 million, which could be substantially reduced to US$16 million through reduced management cost; and, potentially, reduced further through exploring technical efficiency gains. With additional potential efficiency gains through unit cost reductions in FSW, MSM, and PMTCT programs as identified by the country experts, the cost could be reduced to US$15 million. The optimized allocation to achieve national targets also would reduce the total estimated number of PLHIV in 2020 from 10,200 to 8,500 and, thereby, the future costs of the HIV response.

Technical efficiency analysis of core programs would be particularly beneficial in the Kyrgyz Republic because the current cost profile differs from those of other countries and varies among and within programs. Benchmarks for unit costs for key service packages could be set and tracked. It also is essential to critically examine and study the implementation efficiency of the large portion of HIV spending (56 percent), which is allocated to management and other costs.

Compared to overall funding of health programs in the Kyrgyz Republic, of which 60 percent are government funded, 71 percent of HIV expenditures in 2012 was externally funded, thus calling for **increasing the share of domestic financing of the HIV response**.

1. INTRODUCTION: WHY ALLOCATIVE EFFICIENCY ANALYSIS NOW?

1.1 Necessity for allocative efficiency

Current HIV programs are faced with the need to scale up prevention and provide treatment to a larger number of people living with HIV (PLHIV) than ever before. In the current environment of increasingly limited resources for HIV responses, focused design and efficiency in program delivery are essential to ensure that programs can do more with less.

In the 2011 United Nations Political Declaration on HIV and AIDS, countries agreed to reduce sexual and injection-related transmission by 50 percent, virtually eliminate mother-to-child-transmission, initiate 80 percent of eligible PLHIV on treatment, and end HIV-related discrimination by 2015 (UNGASS 2011). UNAIDS' 2014 Gap Report illustrated that, in most countries, substantial additional efforts will be required to achieve these targets. Against this background, UNAIDS globally defined a *Fast-Track* strategy to achieve the goal of *Ending AIDS by 2030* (UNAIDS 2014b). One core element of the Fast-Track approach are the 90-90-90 targets, which set out to achieve that 90 percent of all PLHIV are diagnosed; 90 percent of diagnosed PLHIV are on ART; and 90 percent of PLHIV on ART are virally suppressed (UNAIDS 2014d). The Fast-Track approach also emphasizes the need to focus on the geographic areas and communities most affected by HIV and recommends that resources be concentrated on the programs that make the greatest impact.

In this context, UNAIDS and cosponsors are promoting a shift toward investment thinking in the design of HIV responses globally to maximize the impact of program investment and best realize the long-term health and economic benefits of HIV programs. A number of countries are developing investment cases to understand HIV epidemics as well as to design, deliver, and sustain effective HIV responses. To support HIV investment cases, a group of countries in the ECA Region conducted allocative efficiency (AE) analyses. In 2014–15, AE analyses were carried out by Armenia, Belarus, Georgia, Kazakhstan, the Kyrgyz Republic, Moldova, Tajikistan, Ukraine, and a number of countries outside the ECA Region.[2] This report summarizes the results of the analysis for the Kyrgyz Republic. The investment case is complemented with a human rights-based approach to health care.

The concept of allocative efficiency refers to the maximization of health outcomes, with the least costly mix of health interventions.[3] HIV allocative efficiency studies generally try to answer the question, "*How can HIV funding be optimally allocated to the combination of HIV response interventions that will yield the highest impact?*"

[2] For published study reports see for example Republic of Tajikistan 2014 and Fraser and others 2014.

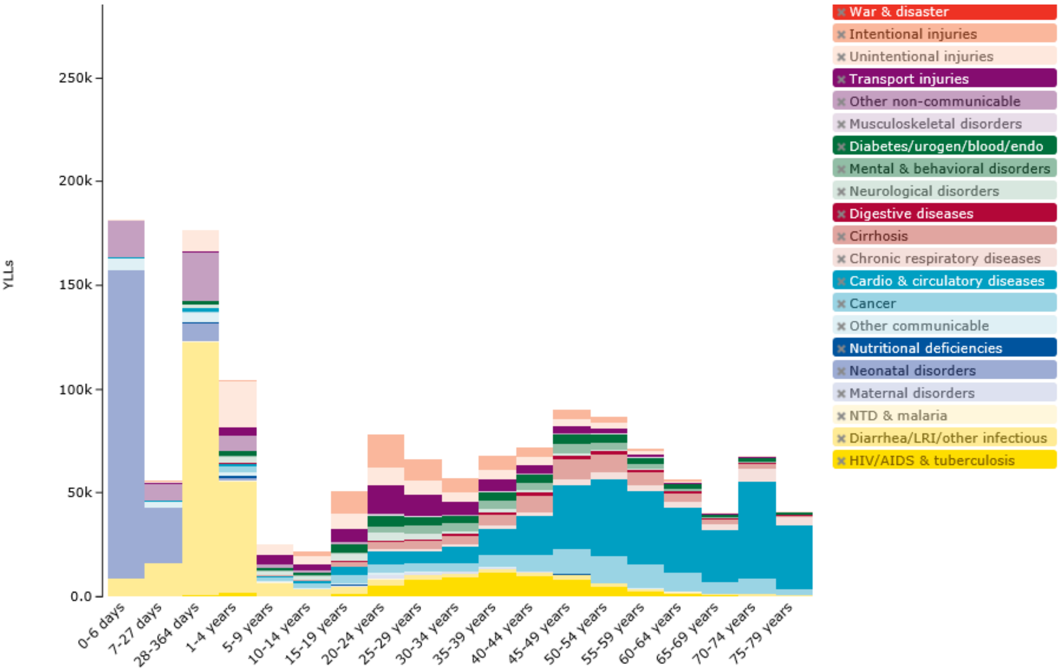
[3] Technically, allocative efficiency can be done within a fixed budget envelope (maximize impact with given amount of money); or within defined impact targets (minimize cost to achieve a given impact).

There is wide consensus that better outcomes could be achieved in many settings with a given amount of HIV funding; or that given outcomes could be achieved with less HIV funding if resources are distributed optimally or if resources are used in the most efficient ways. Mathematical modelling is one way to determine optimized HIV resource allocation.

1.2 The Kyrgyz Republic's burden of disease: HIV in the context of wider health issues

The Kyrgyz Republic's overall burden of disease is characterized by a high contribution of neonatal and child mortality in comparison to other countries in the ECA Region––together with a mix of other causes of disease.

Figure 1.1 Years of life lost (YLL) due to different causes by age, 2010



Source: University of Washington 2014.
Note: LRI = lower respiratory infection; NTD = neglected tropical diseases.

In the population aged 50 and above, noncommunicable diseases, particularly cardio- and circulatory diseases followed by cancer are the dominant causes of years of life lost. In the population of reproductive age (15–49), there are several main causes of disease including injuries, noncommunicable diseases, and HIV/tuberculosis (TB), which in combination have a similar disease burden as all cancers in this age group. HIV and TB account for 4.6 percent of years of life lost (YLL) for all ages and for 11.1 percent of the YLL in the 15–49 age group. HIV alone accounts for 6.1 percent of the YLL in the 15–49 age group (University of Washington 2014). The bulk of this HIV disease burden is concentrated among key populations. HIV prevalence in key populations (FSW, MSM, and PWID including those in prisons) is 10 to 100 times higher than in the general population (Table 1.1). In this context, in addition to the key priorities of neonatal and child health, injuries, and noncommunicable diseases, HIV prevention and treatment that focuses on key populations remains an important component of health service delivery.

1.3 Financing of HIV in the context of health care financing

From 2000 to 2012, overall spending on health in the Kyrgyz Republic saw a 7-fold increase in absolute numbers, and an increased proportion of GDP from 4.7 percent to 7.1 percent. Table 1.1 provides a summary of health spending in the Kyrgyz Republic.

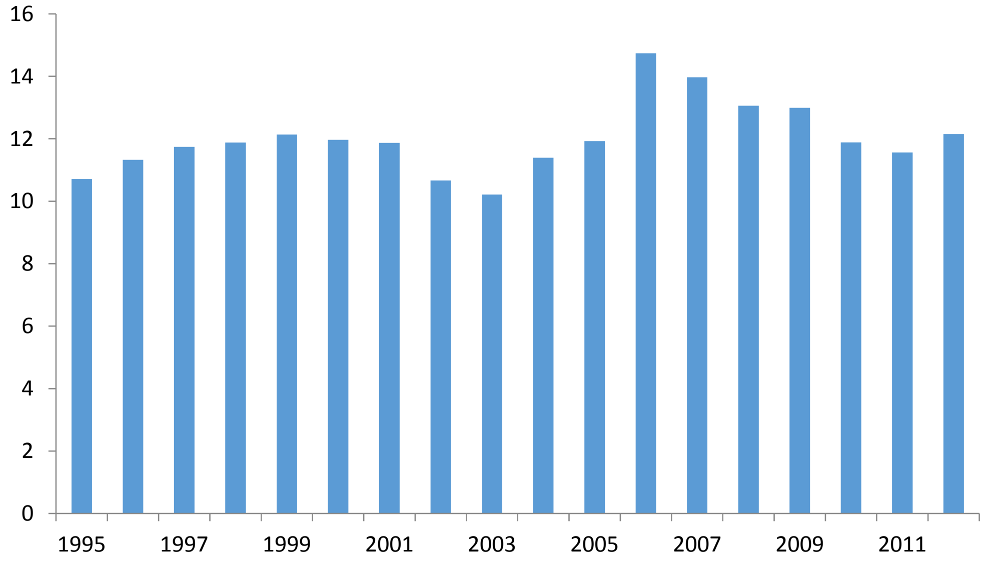
Table 1.1 Overview of health expenditure in the Kyrgyz Republic, 2000–13

Indicator		**2000**	**2005**	**2010**	**2011**	**2012**	**2013**
Total health spending							
Gross domestic product (GDP)	Current US$ million	1,368	2,459	4,784	6,208	6,614	7,226
Total expenditure on health	Current US$ million	64	143	318	384	461	482
Total health expenditure (THE) % GDP	%	5	6	7	6	7	7
Total expenditure on health/capita at exchange rate	Per capita	13	28	60	71	84	87
Government health spending							
General government expenditure	Current US$ million	237	491	1,493	1,987	2,285	2,153
General government expenditure on health (GGHE)	Current US$ million	28	59	177	230	278	285
GGHE as % of general government expenditure	%	12	12	12	12	12	13
GGHE as % of total health expenditure	%	44	41	56	60	60	59
Private health spending							
Private expenditure on health	Current US$ million	36	85	141	154	184	198
Private expenditure on health as % of THE	%	56	59	44	40	40	41
Out-of-pocket expenditure as % of THE	%	50	56	39	34	35	36
Out-of-pocket expenditure as % private health expenditure	%	89	95	87	86	88	89
External funding							
Rest of the world funds/External resources	Current US$ million	4	18	36	42	56	42
External resources on health as % of THE	%	6	13	11	11	12	9

Source: WHO 2014.

From 1995 to 2012, the level of government expenditure on health in the Kyrgyz Republic ranged from 10.0 percent to15.0 percent of general government expenditure. After peaking in 2006, government health expenditure was approximately 12.0 percent of general government expenditure from 2010 onward (Figure 1.2). In 2012, the proportion of government expenditure used for health was slightly above the global average of 11.7 percent.

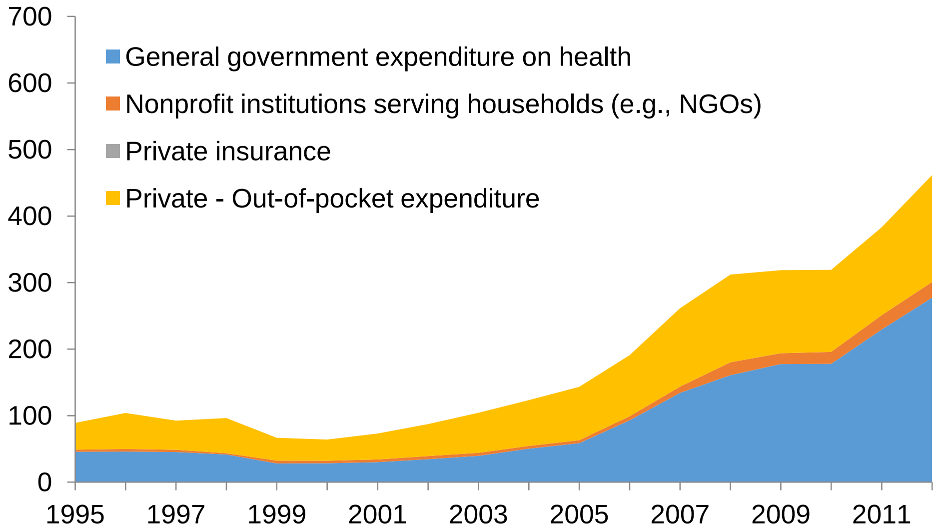
Figure 1.2 Kyrgyz Republic: General government expenditure on health as share of general government expenditure, 1995–2012 (%)



Source: WHO 2014.

In the Kyrgyz Republic, in 2012 government incurred 60.1 percent of health expenditure. Private out-of-pocket expenses accounted for 34.8 percent. The contribution of nonprofit organizations increased since the early 2000s and covered 5.1 percent of total health spending in 2012. AsHealth spending increased substantially in absolute numbers from US$89 million to US$462 million from 1995 to 2012 (Figure 1.3) but also increased moderately in percent of GDP from 6.0 percent in 1995 to 7.1 percent in 2012.

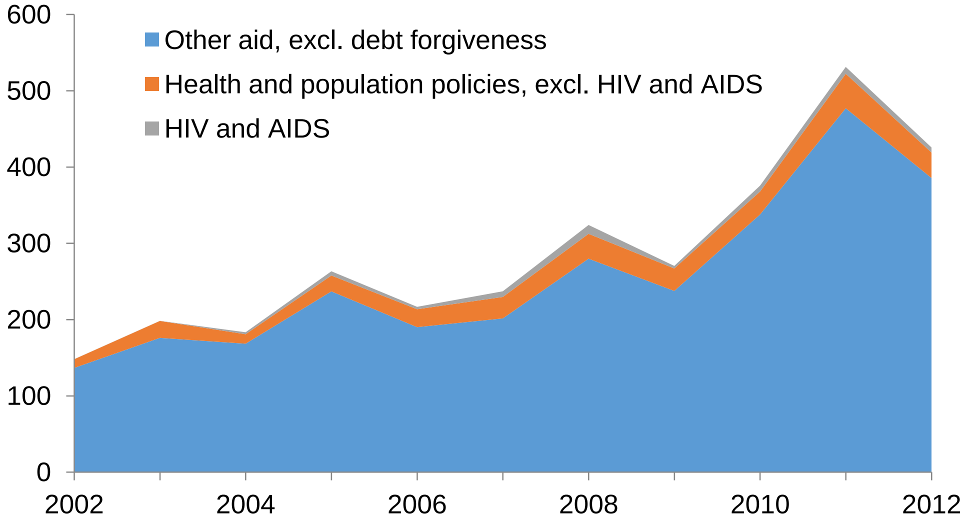
Figure 1.3 Kyrgyz Republic: Health spending by source of financing, 1995–2012 (US$ millions)



Source: WHO 2014.

External assistance to the Kyrgyz Republic increased since the early 2000s and peaked in 2011 at US$477 million (Figure 1.4). Health, population policies, and HIV/AIDS together accounted for approximately 10.0 percent of all external assistance over the past decade and reached 8.7 percent in 2012, while HIV/AIDS alone accounted for 1.7 percent of all external assistance.

Figure 1.4 Aid disbursements, 2002–12 (US$ millions)

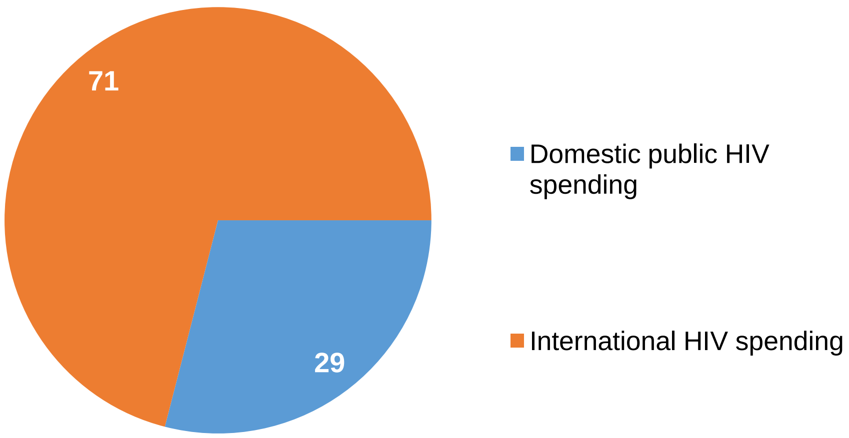


Source: OECD, CRS, 2014.

1.4 Financing of the HIV response in the Kyrgyz Republic

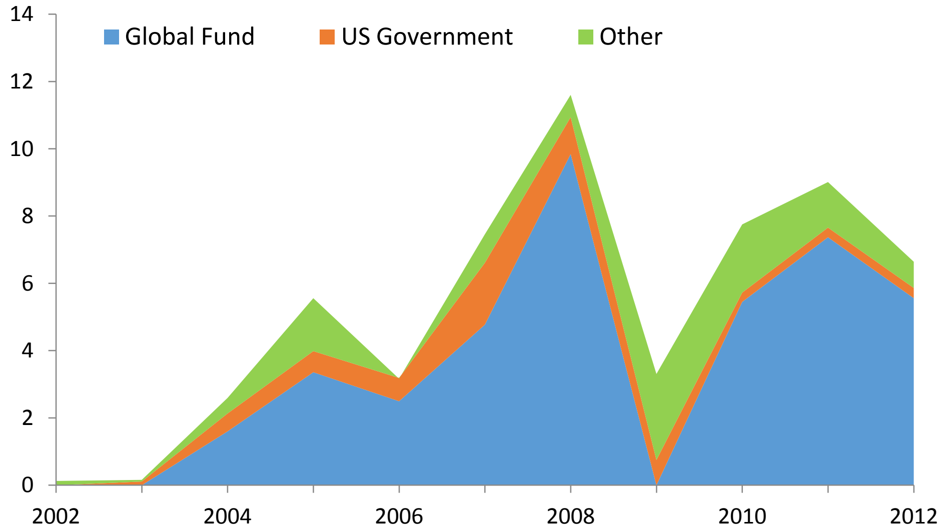
The majority of HIV funding is provided by international partners, which accounted for 71 percent of expenditure on HIV/AIDS in 2012 (Figure 1.5). Twenty-nine percent of all HIV spending was financed by government. In other words, compared to overall funding of health programs in the Kyrgyz Republic, of which 60 percent are government funded, a relatively larger proportion of HIV expenditure is externally funded. Unlike for general health spending, private spending on HIV is assumed to play a smaller role, but exact figures are not available. It can be assumed that there are out-of-pocket expenses for items including condoms and needles in pharmacies as well as for services by private doctors. The Global Fund is the major external funding partner for the Kyrgyz Republic's HIV response, accounting for over 80.0 percent of external support. In 2012, 83.7 percent was provided by the Global Fund; another 4.6 percent by the US Government; and 11.7 percent by other partners (Figure 1.6).

Figure 1.5 Kyrgyz Republic: HIV spending by source of financing, 2012 (%)



Source: aidsinfo online.

Figure 1.6 Kyrgyz Republic: HIV/AIDS-related aid disbursements by donor, 2002–12 (US$ millions)



Source: OECD, CRS 2014.
Note: These are disbursements, which may differ from annual expenditures recorded in NASA reports for some years and funding sources. This comment applies particularly to Global Fund disbursements and actual expenditure, which according to the National AIDS Spending Assessment was not 0 in 2009, but rather US$5.0 million (including funds disbursed earlier).

The economic crisis in North America and Western Europe and the stabilization of international funding for HIV have reduced the prospect of increasing international funding for national HIV responses in the ECA Region. Given the current eligibility and cofinancing requirements under the new funding model of the Global Fund, the primary funding partner for HIV programs in the Kyrgyz Republic, external HIV funding is likely to decline. This likelihood causes concern about the sustainability of the long-term national HIV response and increases the need for domestic financing.

2. WHAT ARE THE KEY QUESTIONS AND HOW WILL THIS REPORT ANSWER THEM?

This section outlines the main steps taken and tools applied to carry out the analyses presented in this report. Additional details are is available in the appendixes.

To support the national strategy priorities and assist the Kyrgyz Republic in meeting its set targets, this report answers the following questions:

1. How can the Kyrgyz Republic optimize the allocation of its current HIV funding?
2. What might be gained from increased investment in HIV programming?
3. What is the minimum spending required to meet national targets and how should funds be allocated to achieve the targets?

Each of these questions is the subject of an analytical module described in more detail in appendix D. Additional more detailed questions on epidemiology and cost-effectiveness also are answered in this report.

2.1 Optima Model

To carry out the analyses, the team used Optima, a mathematical model of HIV transmission and disease progression integrated with an economic and program analysis framework. Optima uses HIV epidemic modeling techniques and incorporates evidence on biological transmission probabilities, detailed infection progression, sexual mixing patterns, and drug injection behaviors. In consultation with the Kyrgyz Republic experts, Optima was calibrated to HIV prevalence data points available for the different subpopulations (including female sex workers, injecting drug users, and men who have sex with men), as well as to data points on the number of people on ART.

To assess how incremental changes in spending affect HIV epidemics and determine an optimized funding allocation, the model parameterizes relationships among the cost of HIV intervention programs, the coverage level attained by these programs, and the resulting outcomes (Table 2.1). These relationships are specific to the country, population, and prevention program being considered.

Using the relationships among cost, coverage, and outcome in combination with Optima's epidemic module, it is possible to calculate how incremental changes in the level of funding allocated to each program will impact on overall epidemic outcomes. Furthermore, by using a mathematical optimization algorithm, Optima is able to determine an optimized allocation of funding across different HIV programs. Additional details about Optima are in appendix A.

2.2 Analytical framework

The study was conceptualized by a Regional steering group involving the Global Fund, UNAIDS, UNDP, and convened by the World Bank. A national technical group convened by UNAIDS in collaboration with the government was formed. Country-specific objectives of the analysis and parameters were outlined in a Scope of Work document. Epidemiological, program, and cost data were collected by in-country experts with technical support from international partners using an adapted MS-Excel-based Optima data entry spreadsheet. In November 2014, a regional mathematical modelling workshop was conducted in Yerevan, Armenia. In this workshop, national experts and specialists from international partners worked together with UNSW mathematical modelers to carry out modelling analyses using the Matlab software package. This Regional process also aimed at data comparison, exchange, quality assurance, and development of capacities in HIV epidemic and response analysis using mathematical modelling techniques. The team then consulted with government experts and other in-country partners on the preliminary results and summarized them in this report.

Table 2.1 Modelling parameterization

Category	Parametrization in Optima model	Description/Assumptions
Populations defined in model	Female sex workers	Females, aged 15–49
	Clients of sex workers	Males, aged 15–49
	Men who have sex with men	Males, aged 15–49
	Men who inject drugs	Males, aged 15–49
	Women who inject drugs	Females, aged 15–49
	Boys	Males, aged 0–14
	Girls	Females, aged 0–14
	Male youth	Males, aged 15–24
	Female youth	Females, aged 15–24
	Male adults	Males, aged 25–49
	Female adults	Females, aged 25–49
	Older men	Males, aged 50+
	Older females	Females, aged 50+
Expenditure areas defined in model and included in optimization analysis	Prevention programs for female sex workers	Condom distribution, HIV testing and counselling, community outreach
	Prevention programs for MSM	Condom distribution, HIV testing and counselling, community outreach
	Needle and syringe exchange and related prevention for PWID	Needle and syringe exchange, condom distribution, HIV testing and counselling, community outreach
	Opioid substitution therapy	Provision of medication and related counselling
	HIV testing and counselling	HIV test kits and pre- and post-testing counselling
	Antiretroviral therapy	Antiretroviral drugs, related laboratory monitoring and clinical visits
	Prevention of mother to child transmission	HIV testing of pregnant women, counselling, and provision of antiretroviral prophylaxis for women living with HIV
Expenditure areas not included in optimization (effectiveness in reducing HIV incidence, morbidity/mortality not known, or indirect effects)	Management and other costs	Management, coordination, advocacy, and support for PLHIV, monitoring, evaluation, surveillance, research, enabling environment, human resources (detailed breakdown below)

Table 2.1 Modelling parametrization *(Continued)*

Category	Parametrization in Optima model	Description/Assumptions
Time frames	2014 (baseline) 2015–20 period for optimization	Available data from 2000 to 2014 were used. Projections started with the year 2015. Optimizations were performed up to 2020 (main body of report) and 2030 (appendix E).
Baseline scenario funding	US$12.6 million (2013)	2013 spending as per Optima spreadsheet in line with NASA report of the Kyrgyz Republic for 2012–13, Bishkek, 2014 (Russian version).

Note: A comprehensive four-pronged approach to PMTCT includes other elements such as the provision of contraception. Because the primary purpose of contraception for the vast majority of women in this concentrated epidemic setting is not PMTCT but pregnancy prevention, contraception cost was not included in this analysis (apart from the cost for condom promotion to key populations covered in FSW, MSM, and PWID programs). The same logic applies to other related services.

Table 2.2 describes the populations and programs included in the analysis as well the relevant time frames. “Direct programs” with a proven and quantifiable effect on HIV incidence and/or deaths are included in the mathematical optimization analysis; management and other costs (“indirect programs”) are treated as fixed costs. Within direct programs, some service packages target specific key populations (FSW, MSM, and PWID); others (HTC, ART, PMTCT) cut across all populations, including key populations.

Table 2.2 Costs per person reached as per the populated Optima spreadsheet (US$)

Cost per person reached	Kyrgyz Republic[a]	Kazakhstan[a]	Other countries in the Region (program management cost and human resources included in the program cost)			
			Lowest	Highest	Average	Median
FSW programs	103.65	34.13	41.66	166.24	102.94	105.35
MSM programs	449.13	13.46	23.67	449.13	159.45	71.25
PWID-NSP programs	116.38	56.43	40.90	129.25	109.73	84.11
OST	509.51	378.17	431.41	1,645.24	747.36	790.23
PMTCT[b]	6,999.10	n.a.	738.08	8,905.27	4,616.80	4,267.59
ART	861.55	2,278.52	576.48	2,278.52	1,203.26	1,127.29

Source: Populated Optima data entry spreadsheets from 7 countries.
Note: Table 2.2 reflects how costs were categorized by countries for this analysis. The analysis is not based on detailed matching of classification of inputs, but on how countries classified expenses using the detailed available guidance for NASA and GARPR reports. Although this guidance is detailed and specific, differences cannot be ruled out, particularly when regarding cross-cutting costs such as HR costs. In addition, even if costs are classified consistently, the comprehensiveness of service packages may differ; a = Program management cost and human resources are not included in the program cost; b = Total program cost divided by the number of HIV-positive pregnant women receiving ARV prophylaxis/ART.

Based on program spending per person reached, cost-coverage outcome relations were developed. Calibrations and cost-coverage outcome relations were produced in collaboration with the Kyrgyz Republic experts and are shown in appendixes B and C.

Costs per person reached derived from service output information and total spending on programs are presented in Table 2.2. These are not unit costs, and definitions of program coverage vary among countries. It also is important to note that the Kyrgyz Republic and Kazakhstan used a different approach of accounting for human resource expenses and management cost of specific programs. In these two countries, such costs were included in the general management cost. Therefore, for them, management costs were higher than in the other countries, while program costs were reduced. Costs per person reached in the Kyrgyz

Republic appear to be higher than in neighboring Kazakhstan for prevention programs, but lower for treatment. Detailed analysis of program packages, unit costs, and service delivery modalities goes beyond the scope of this report. However, the magnitude of the differences in costs per person reached warrants additional attention, potentially through a technical efficiency analysis.

2.3 National targets and how they were translated into Optima

Analyses were informed by national priorities. The Kyrgyz Republic has set the priorities for its HIV response in the ***State Programme on Stabilization of the HIV Epidemic in the Kyrgyz Republic for 2012–16***[4] including key coverage, outcome, and impact targets:

Strategy 1. Decreasing the vulnerability of PWID to HIV

- Fewer than 20 percent of PWID are infected with HIV by 2016 (impact)
- At least 60 percent of PWID are covered by HIV prevention by 2016 (coverage)
- Fewer than 15 percent of prisoners are infected by HIV by 2016 (impact)

Strategy 2. Preventing sexual HIV transmission

- Fewer than 1 percent of youth in age 15–24 (pregnant women) are infected with HIV by 2016 *(impact)*
- Fewer than 5 percent of sex workers and MSM are infected by HIV by 2016 *(impact)*
- At least 60 percent of sex workers and 30 percent of MSM are covered by HIV prevention by 2016 *(coverage)*

Strategy 3. Providing access to treatment care and support to PLHIV

- 40 percent of all estimated adults and children living with HIV will get ART by 2016 *(coverage/outcome)*
- At least 85 percent of HIV positive adults and children will be on treatment after 12 months by 2016 *(outcome/ impact)*
- Fewer than 25 percent of HIV deaths would be connected with TB deaths by 2016 *(impact)*
- More than 90 percent of HIV-positive pregnant women will get ART for decreasing mother-to-child HIV transmission by 2016 *(outcome)*
- Fewer than 3 percent of infants born to HIV-positive mothers are infected by HIV by 2016 *(impact).*

The country also has set out that, by 2020, the targets of the 2011 Political Declaration would be achieved, particularly the following:

- Sexual HIV transmission is decreased by 50 percent.
- HIV transmission through unsterile injections is decreased by 50 percent.
- TB-related deaths are decreased by 50 percent.
- Eighty percent of eligible PLHIV are receiving ARV treatment.
- Mother-to-child-transmission is eliminated.
- HIV-related stigma and discrimination will be decreased by 90 percent.

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[4] Ministry of Health, the Kyrgyz Republic 2012.

For the purpose of modelling, these national targets had to be simplified. Simplification was necessary because many national targets had been set as HIV prevalence targets. They are not suitable for optimization analysis because new infections increase prevalence while deaths reduce it. Therefore, the targets and commitments were translated into 2 sets of key impacts targets summarized in Table 2.3.

Table 2.3 National targets as applied in optimization analysis

Targets	AIDS-related deaths	HIV infections	Mother-to-child-transmission
Conservative	No increase in annual deaths in 2020 compared to 2014 levels	No increase in annual new infections in 2020 compared to 2014 levels	Virtual elimination of MTCT: Fewer than 5% of infants born to HIV-positive mothers who breastfeed, and fewer than 3% born to HIV-positive mothers who do not breastfeed, are infected
National	50% reduction in annual deaths in 2020 compared to 2014 levels	50% reduction in annual new infections in 2020 compared to 2014 levels	Virtual elimination of MTCT: Fewer than 5% of infants born to HIV-positive mothers who breastfeed, and fewer than 3% born to HIV-positive mothers who do not breastfeed, are infected

2.4 Limitations of the analyses

Similar to any mathematical modelling analysis, this study is based on a number of assumptions, which necessarily imply specific limitations:

- As for other countries with concentrated epidemics, there are some gaps in data, particularly for the general population. As in other models, estimates of HIV prevalence in the general population were derived from data in pregnant women used as a proxy for prevalence in the general population.
- For this analysis, standard classification of cost data in line with National AIDS Spending Assessments (NASA) was used, but differences in program packages among countries limit the comparability of findings.
- To determine overall cost per person reached, the analysis used past ratios of expenditure to coverage rather than unit costs from a costing of future programs. This approach of using past cost and coverage has a number of advantages over using projected costs from plans and budgets, which ultimately are predictions of future cost. The approach also has a disadvantage: there may be future increases or decreases in cost in relation to new approaches, implementation arrangements, or technologies.
- The modeling approach used to calculate relative cost-effectiveness among programs includes assumptions concerning the impact of increases or decreases in funding for programs. These assumptions are based on costs per person reached and observed ecological relationships among outcomes of program coverage or risk behavior and the amount of money spent on programs in the past. Another assumption was some saturation in the possible effects of programs caused by increased spending.
- The analysis did not determine the technical efficiency of programs. Gains in technical efficiency would lead to different unit costs so would affect resource allocation.
- Modelling the optimization of allocative efficiencies depends critically on the availability of evidence-based parameter estimates of the effectiveness of individual interventions. Although these estimates were derived from a global systematic literature review,[5] they

5 The full literature review is available at www.optimamodel.com.

may vary in specific countries and populations depending on various factors, particularly the levels of adherence to interventions. All programs and spending categories, for which such parameters cannot be obtained, such as enablers and synergies, could not be included in the mathematical optimization. Because they still have important functions in the HIV response, they were treated as fixed costs and, in some specific scenarios, adjusted with specific justifications.

- Effects outside the HIV endpoints are complex to consider (such as non-health benefits of OST, effects of needle exchange on hepatitis, effects of condoms on contraception, and STIs). Given that the majority of OST benefits occur beyond HIV outcomes, specific consideration was given to the non-HIV benefits of OST (appendix A). Given the complexity of interactions among interventions and their non-HIV benefits, this approach was applied only for OST. Similarly, the model does not seek to quantify human rights; stigma and discrimination; and ethical, legal, or psychosocial implications; but acknowledges that they are important aspects to be considered.

3. WHAT ARE THE EXPECTED TRENDS IN THE EPIDEMIC IF CURRENT CONDITIONS ARE MAINTAINED?

Chapter 3 summarizes the current HIV status in the Kyrgyz Republic based on key national data and the epidemic trends generated by Optima. The model assumed that current conditions would continue until 2020.

3.1 Summary of key national data on the HIV epidemic

Table 3.1 provides key national HIV-related data in the Kyrgyz Republic including data on new HIV diagnoses, registered deaths due to AIDS, prevalence in key populations, coverage of key services, and self-reported modes of HIV transmission.

By the end of 2013, the Kyrgyz Republic had registered over 5,100 persons diagnosed with HIV, of whom over 3,900 were still registered and alive in 2013. The cumulative number of registered deaths due to AIDS was below 300 at the end of 2013. This means that approximately one fifth of diagnosed PLHIV are neither represented in the number of currently registered PLHIV nor included in the registered deaths. This difference suggests that some PLHIV were lost to follow up, died from other causes or died from AIDS, but were not registered as AIDS deaths. ART coverage is relatively low with less than 20 percent of the total estimated PLHIV population and less than 33 percent of the registered PLHIV are currently on ART.

In 1 decade, new HIV diagnoses increased sharply from fewer than 20 per year in 2000 to over 500 per year after 2010. Self-reported data on the likely source of transmission suggest a reduced share of infections due to drug-injecting behavior and an increase in sexual transmission, which, for the first time, in 2013, accounted for over 50 percent of new diagnoses.

Table 3.1 Key national HIV-related data in *the Kyrgyz Republic*, 2000–13

	2000	2005	2010	2011	2012	2013	Source
HIV diagnoses							
Cumulative number of people diagnosed with HIV, total number	53	825	3,287	3,886	4,610	5,114	National AIDS Center, routine HIV testing
Cumulative registered number of people diagnosed with HIV and alive, total number	13	636	2,627	3,111	3,641	3,940	
Number of people newly diagnosed with HIV							
Total	16	171	570	599	724	504	National AIDS Center, routine HIV testing
Ages 15–older	4	159	527	542	568	480	
Ages 0–14	0	6	43	57	156	24	
Females	1	51	170	182	306	212	
Males	15	120	400	417	418	292	
Registered deaths due to AIDS							
Annual registered number of deaths	1	22	31	39	53	45	National AIDS Center
Cumulative registered number of deaths	1	46	155	194	247	292	
HIV prevalence among key populations							
HIV prevalence among sex workers (%)		1.10	3.50			2.2	National AIDS Center, IBBS
HIV prevalence among MSM (%)			1.10			6.3	
HIV prevalence among PWID (%)		8.00	14.6			12.4	
HIV prevalence among prison inmates (%)		0.40	13.7			7.6	
Service coverage and utilization							
Number of people receiving ART	0	0	356	510	691	1,074	National AIDS Center
Coverage of ART (% of registered people living with HIV)	0	0	13.2	16.1	18.6	26.7	
Coverage of ART (receiving ART as a % of estimated people living with HIV	0	0	5.6	7.3	9.1	13.4	
Number of syringes distributed per estimated PWID			220	151	253	292	GARPR
Estimated PWID receiving OST (%)				4.0	3.8	4.4	National Narcologic Center
Self-reported modes of HIV transmission (% of newly diagnosed)							
Sexual HIV transmission	12.5	34.5	33	30.1	43.2	57.7	National AIDS Center
HIV transmission through	87.5	64.3	59.6	60.4	35.5	37.3	
HIV transmission through unsafe blood or blood products	0	0.0	0.0	0	0	0	
Vertical HIV transmission	0	1.2	3.5	3	5	2	

Source: Prepared by authors based on sources in the column to the right.

3.2 Epidemic trends projected in Optima

Optima projections were made assuming that current trends in transmission-related behaviors would be maintained. As mentioned above, appendixes A and B describe the process and some of the data used to generate these estimations and projections.

Table 3.2 shows some key estimates for 2014 and 2020 from Optima. The estimated number of PLHIV in 2014 is very similar to the 2013 estimate of 8,000 PLHIV generated using Spectrum.[6] The Optima-generated estimates of new infections and deaths also are within the confidence bounds of global estimates, suggesting that there were fewer than 1,300 new infections and fewer than 500 deaths in 2013.

Table 3.2 Estimates of key indicators from Optima projections, 2014 and 2020

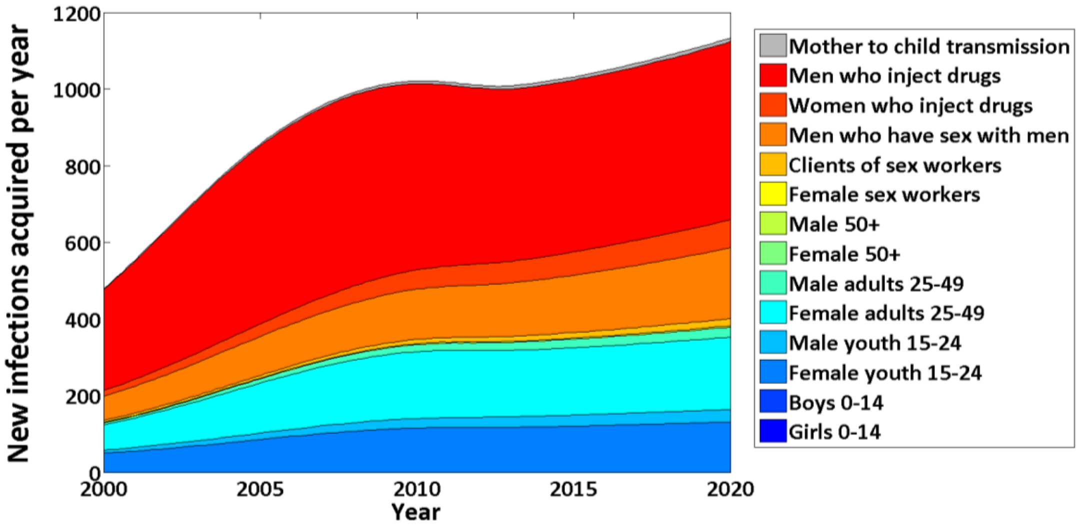
	PLHIV		Prevalence (%)		New infections		AIDS deaths	
	2014	2020	2014	2020	2014	2020	2014	2020
Girls 0–14	<50	<50	0.0	0.0	<5	<5	<5	<5
Boys 0–14	<50	<50	0.0	0.0	<5	<5	<5	<5
Female youth 15–24	600	700	0.1	0.1	120	140	20	40
Male youth 15–24	200	300	0.0	0.0	30	40	10	20
Female adults 25–49	1,400	1,800	0.2	0.2	170	210	70	120
Male adults 25–49	300	400	0.0	0.0	20	30	20	40
Female 50+	100	100	0.0	0.0	<5	<5	10	20
Male 50+	<50	<50	0.0	0.0	<5	<5	<5	<5
Female sex workers	200	300	2.7	3.7	<5	<5	10	20
Clients of sex workers	300	400	0.1	0.2	10	20	20	40
Men who have sex with men	1,100	1,600	4.5	5.9	140	220	50	100
Women who inject drugs	300	300	10.3	11.6	60	60	10	20
Men who inject drugs	3,900	4,100	17.9	17.3	450	440	190	280
Total	**8,400**	**10,100**	**0.15**	**0.17**	**1,010**	**1,150**	**430**	**700**

Source: Populated Optima model for the Kyrgyz Republic.

The model-predicted evolution of annual HIV incidence (2000–20) in each subpopulation is shown in Figure 3.3. Men and women who inject drugs continue to account for nearly half of the estimated 1,000 new infections, but the number of new infections in this group has stabilized. New HIV infections in other groups are projected to increase moderately from 2015 on, particularly among MSM.

6 UNAIDS 2014c, appendix: Global HIV Estimates tables.

Figure 3.1 Model-predicted evolution of annual HIV incidence, 2000–20



Source: Populated Optima model for the Kyrgyz Republic.

The stabilization of the number of new infections estimated in Optima approximately in 2010 is consistent with a stabilization of new HIV diagnoses in National AIDS Center HTC records around the same time.[7] The shift in modes of transmission from drug-injection-related transmission to sexual transmission, which can be observed in National AIDS Center records, also is seen in Optima projections. The fact that the proportion of drug-injection-related transmission is slightly lower in the self-reported data in 2013 could indicate a trend. However, because the value was for a single year, this possible trend will require additional data points. Therefore, it will be important for the country to continue tracking modes of transmission both through self-reported sources of transmission reported during HTC and through modelling projections based on HIV prevalence data.

On its current trajectory, HIV prevalence in the Kyrgyz Republic is expected to increase for two reasons. The first is the moderate increase in HIV incidence. Second, the number of new infections still exceeds the number of deaths, despite the fact that deaths also are projected to increase. As a result of high HIV prevalence in male PWID and increasing prevalence among MSM and FSW clients, continued sexual transmission to female partners is projected to lead to moderate increases in HIV prevalence among female adults.

The model projects an **increase in the number of PLHIV from 8,400 to approximately 10,200** by 2020, assuming current spending will be maintained. This projected increase in PLHIV also implies an increase in the need for treatment, which by 2020 and applying the 90-90-90 targets, is projected to be 3,800 (CD<350), 4,800 (CD4<500), and approximately 8,100.

In summary, the Kyrgyz Republic's HIV epidemic has grown substantially over the past decade. Under current conditions, the epidemic is projected to continue to grow moderately, which could widen the coverage gap for key HIV services.

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7 This comparison is limited by the delay between infection and diagnosis.

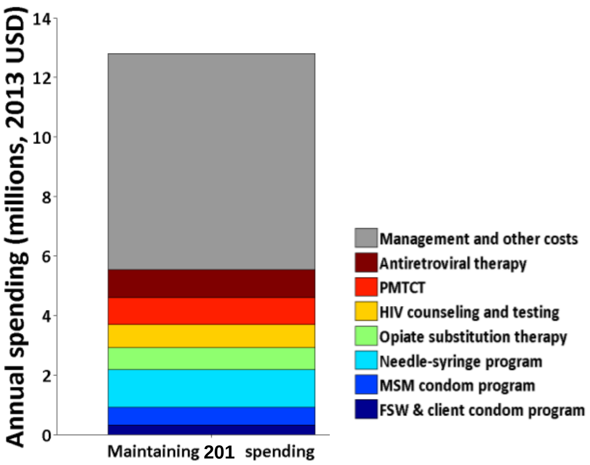
4. WHAT ARE THE IMPACTS OF CURRENT SPENDING?

This chapter describes the programmatic focus of HIV spending in the Kyrgyz Republic and the corresponding epidemiological outcomes.

4.1 Focus of current HIV programs in the Kyrgyz Republic

Figure 4.1 summarizes 2013 expenditure on HIV in the Kyrgyz Republic by program area based on data from the national GARPR financial reporting tables.[8] Less than 10 percent of the country's HIV spending goes to ART. Thus, the proportion of expenditure going to treatment is lower than in most other countries in the Regional allocative efficiency analysis. Conversely, the share of costs classified as management and other costs is 56 percent, which is high in Regional comparison and is explained in part by the country's classification of program-related human resource cost as management cost. The result is that the Kyrgyz Republic's overall HIV investment per capita and per person living with HIV has the appearance of being relatively high in Regional comparison.[9]

Figure 4.1 HIV expenditure in *the Kyrgyz Republic* by program areas, 2013 (US$ million)



Cost category	US$	%
Management and other costs including program-related HR costs	7,061,570	56
Antiretroviral therapy	925,307	7
PMTCT	902,884	7
HIV counselling and testing	787,196	6
Opioid substitution therapy	730,636	6
Needle-syringe program	1,275,822	10
MSM prevention program	595,999	5
FSW and client prevention program	313,024	2
Total	**12,592,438**	**100**

Source: Populated Optima data entry spreadsheet for the Kyrgyz Republic, based on 2013 GARPR financial reporting component.

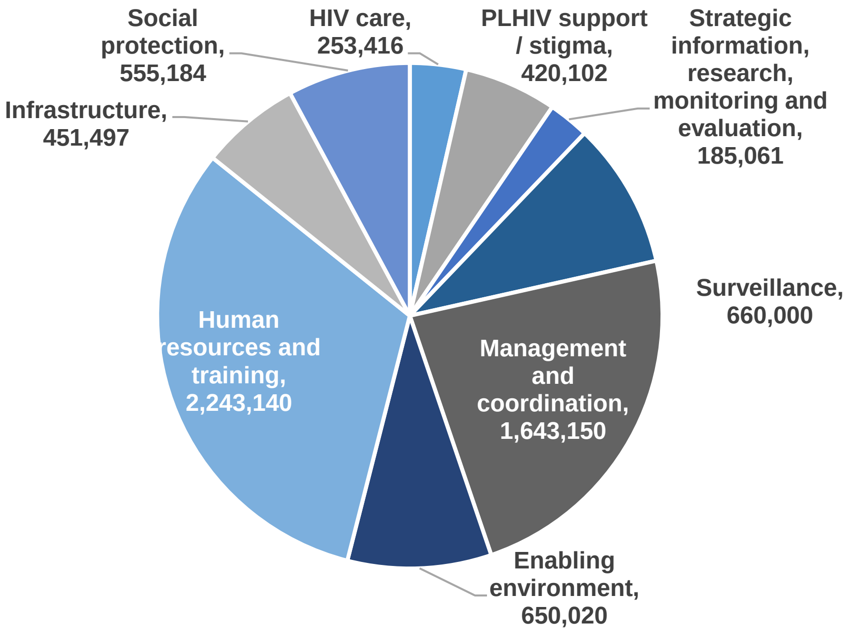
A breakdown of management and other costs is shown in Figure 4.2, which provides insights into the range of activities and costs that could not be included in the mathematical optimization analysis. US$3.9 million—equal to more than 50 percent of all management and other costs and 31 percent of total HIV spending (combined? Or individually?)—were allocated

8 Optima data spreadsheet based on Republic of Kyrgyz Republic, NASA report Kyrgyz Republic for 2012–2013, Bishkek, 2014 (Russian version).

9 Author's calculation based on national HIV estimates and total HIV expenditure per the Optima data spreadsheet, which was derived from the NASA report.

for the 2 categories of management and coordination, and human resources and training. Although they were part of national reporting, expenditures for STI management (US$2.5 million in 2013) and blood safety/universal precautions (US$3.4 million in 2013) are not included here within the management and other costs because those expenses are considered part of wider health services rather than primarily HIV related.

Figure 4.2 Breakdown of management and other costs, 2013 (US$)



Source: Populated Optima data entry spreadsheet on Republic of Kyrgyz, based on 2013 GARPR financial reporting component.

4.2 Without current programs, the increases in new infections, deaths, and PLHIV would be substantially more pronounced

The impacts of current spending can be assessed by comparing projected epidemic trends under current conditions and under zero spending. As described in the previous chapter, under current spending, HIV prevalence and deaths are projected to increase. At the same time, incidence initially would stabilize but then would increase moderately over time.

The effect of stopping current programs up to 2020 was projected and in this scenario zero coverage assumptions were used for all programs and compared to a scenario, in which current spending levels and patterns are sustained (Table 4.1). The projection suggests that, with no programs, by 2020 5,600 AIDS related deaths would occur, 47 percent more than with current programs. However, even maintaining the current, relatively low ART coverage would lead to increasing deaths – a pattern, which is consistent with a growing HIV epidemic, in which the proportion of PLHIV in advanced stages of disease and the need for ART would increase over time. Maintaining 2014 coverage of ART would imply that deaths would rise from 430 in 2014 to more than 600 per year on average between 2015-20 and that, cumulatively, approximately 3,800 AIDS-related deaths would be incurred over the same period.

New infections would be 27,200 with no programs which is more than four times higher than 6,500 new infections expected with current program spending continued between 2015-20. In line with the spending pattern, which focuses on prevention including for key populations, this projection suggests that sustaining the 2013 spending levels and patterns prevents 20,700 new infections by 2020 compared to no programs. In the absence of programs, a sharp rise in new infections would be driven in part by increased needle-sharing.

With no current programs, as a consequence of sharply rising new infections, the number of PLHIV is projected to increase from 8,400 in 2014 to 28,100. Adult HIV prevalence would rise to 0.46 percent with no programs compared to 0.17 percent with programs.

Table 4.1 Projected epidemic outcomes with and without current programs, 2015–20

Coverage /Impact indicator	With no HIV spending (%)	With current spending (%)
FSW and client prevention program coverage (%)	0	40
MSM prevention program coverage (%)	0	8
Needle-syringe program coverage (%)	0	42
Opioid substitution therapy program coverage (%)	0	4
People living with HIV who know their status (%)	13	63
PMTCT program coverage (%)	0	88
Antiretroviral therapy coverage (eligibility: <500 dx) (%)	0	34
Antiretroviral therapy coverage (eligibility: <350 dx) (%)	0	43
Those on treatment who are virally suppressed (%)	N/A	87
Number on 1st-line treatment	0	1,500
Number on 2d-line treatment	0	100
Number eligible for treatment (eligibility: <500 dx)	3,000	4,800
Number eligible for treatment (eligibility: <350 dx)	2,400	3,800
Epidemic outcomes		
Cumulative new infections 2015–20	27,200	6,500
Cumulative AIDS-related deaths 2015–20	5,600	3,800
Cumulative DALYs 2015–20	68,400	52,300
Overall prevalence 2020 (%)	0.46	0.17
Number of people living with HIV 2020	28,100	10,200

Source: Populated Optima model for Republic of Kyrgyz.

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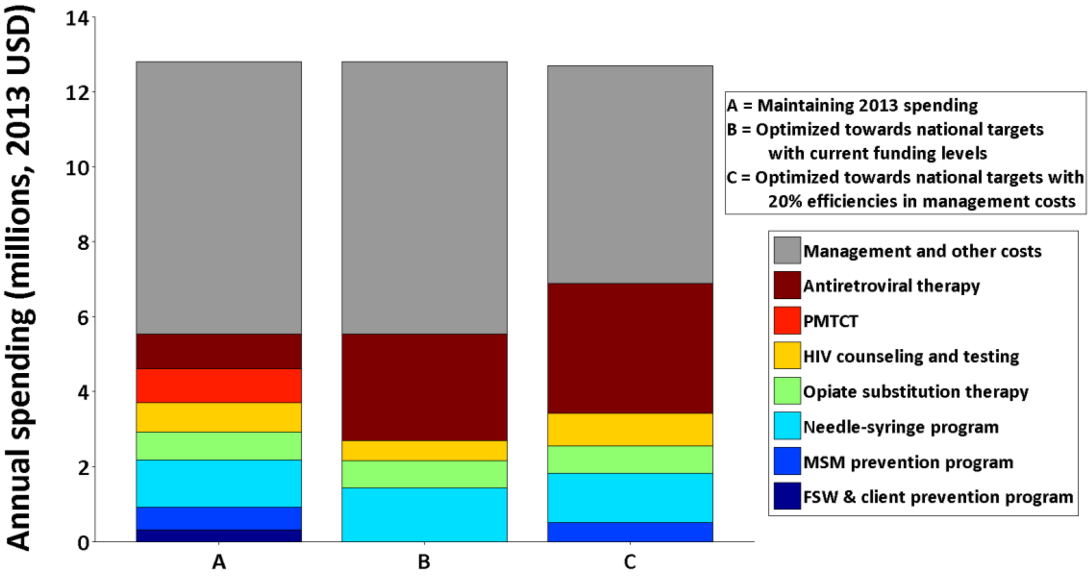
5. HOW WILL OUTCOMES IMPROVE BY OPTIMIZING ALLOCATIONS UNDER THE CURRENT LEVEL OF FUNDING?

An optimization analysis was conducted comparing the impacts that can be achieved in future with the same level of funding that was available in 2013 ($12.6 million). Figure 5.1 shows the current allocation and 2 optimized allocations for the same level of funding.

Figure 5.1 Optimizing spending to get as close as possible to national impact targets with 2013 spending levels, 2015–20



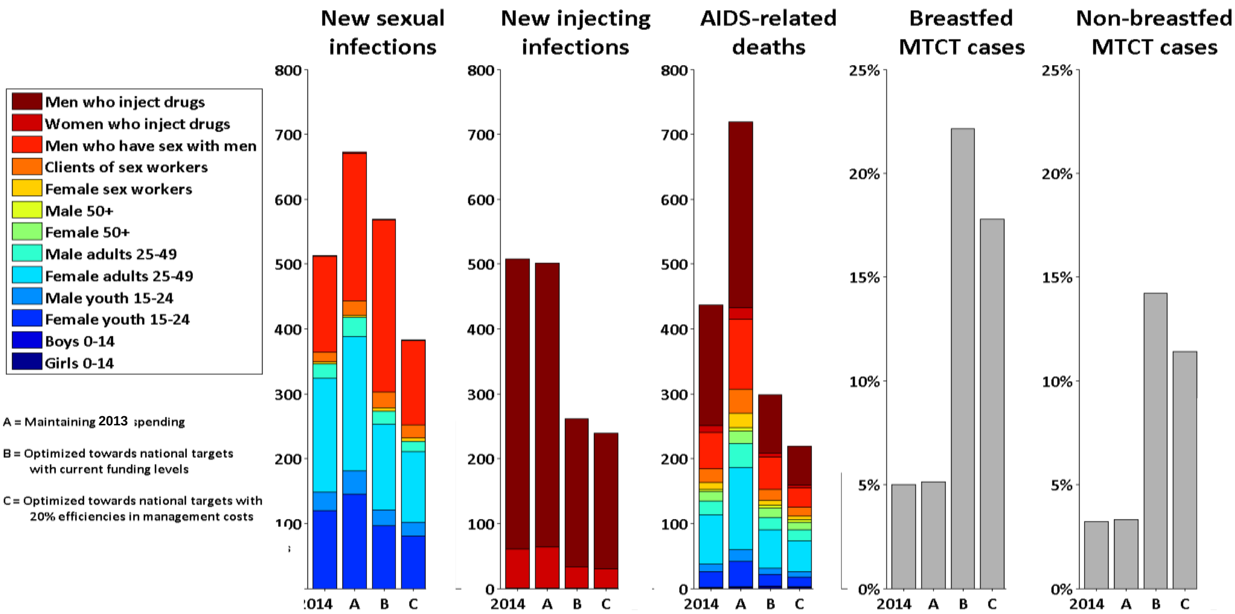
Source: Populated Optima model for the Kyrgyz Republic.

For this analysis, the national strategy targets were interpreted as a 50 percent reduction in both new HIV infections and AIDS-related deaths from 2013 levels by 2020, and the virtual elimination of MTCT. Allocation A represents 2013 spending allocations in the Kyrgyz Republic. Allocation B represents the optimized redistribution of the 2013 budget to get as close as possible to the national strategy targets. Allocation C shows a very similar scenario. However, in this case, the distribution of resources to "management and other costs" is reduced by 20 percent and is redirected to the direct HIV programs considered in the mathematical optimization analysis.

The optimized allocations suggest that, with current funding, impact on new infections and deaths could be increased most substantially through a combination of scaling up ART and sustaining levels of investment in programs for PWID including NSP and OST as well as HTC. If management and other costs could be reduced (Allocation C), additional funding for further ART scale-up and FSW programs would become available.

Although optimization led to substantial reductions in new infections and deaths, national targets could not be fully achieved with the given level of funding and the cost-coverage-outcome assumptions. Figure 5.2 and Table 5.1 illustrate the health outcomes of implementing such an allocation. Figure 5.2 illustrates that Allocation B (optimized allocations with current management cost) could substantially reduce overall new infections by 28 percent and deaths by 53 percent. These percents translate to 1,800 new infections and 2,000 deaths averted. Optima suggests that Allocation B would focus funds on the programs that showed the highest impact on incidence and deaths: ART and PWID programs. Although this combination would increase the MTCT rates, the effects on deaths and injection-related infections would be so strong that this combination of investment would increase overall impact.

Figure 5.2 Comparison of annual epidemic outcomes for optimized allocations to get as close as possible to national targets by 2020 with current (2013) levels of funding, 2015–20



Source: Populated Optima model for Republic of Kyrgyz.

In line with the global elimination targets for MTCT, "breastfed MTCT cases" and "non-breastfed MTCT cases" are defined here as the proportion of HIV-positive women who transmit HIV to their babies disaggregated by the women's breastfeeding status. Because MTCT accounts for approximately 2 percent of new infections, the optimization prioritized achieving reductions in new sexual and injection-related infections, each of which accounts for approximately 50 percent of all HIV infections. PMTCT programs remain critical from a child rights perspective. However, for to be cost-effective in a context of limited resources, PMTCT programs would need to be implemented with reduced unit costs. Another dimension to consider in the cost of PMTCT programming is geographical disparity. HIV prevalence among pregnant women ranged between 1.6 per 10,000 women (0.016 percent) in Naryn Oblast (province) to 12.1 per 10,000 women (0.12 percent) in Bishkek City. The levels of HIV prevalence among key populations (2.2 percent among FSW, 6.3 percent among MSM, and 12.4 percent among PWID) are more than 100 times higher than HIV prevalence among pregnant women in rural oblasts. Clearly, high HIV testing followed by initiation of ART among key populations and their sexual partners must be of highest priority in the Kyrgyz Republic.

Figure 5.2 also shows how close Allocation C (optimized allocations with reduced management cost) comes to achieve the national targets by 2020. The analyses suggest that Allocation C would be the most strategic use of current resources with current funding and current unit costs. In addition to reducing injection-related infections and deaths by 50 percent (which would imply reaching the 2020 target), Allocation C reduces sexual transmission by 25 percent. For the same reasons cited above, no funding would be allocated to PMTCT so MTCT would rise. Nevertheless, because MTCT accounts for less than 2 percent of new infections, it would not influence allocations.

Table 5.1 Program coverage levels, epidemiological outcomes, and cost-effectiveness calculations relating the spending scenarios described

Analysis to end of 2020	Maintaining 2013 spending (Allocation A) (US$)	Optimized toward national targets with current funding levels (Allocation B) (US$)	Optimized toward national targets with current funding with 20% efficiencies in management costs (Allocation C) (US$)
Annual allocations between 2015-20 (average)			
Allocation to FSW and client prevention program	313,024	0[a]	0[a]
Allocation to MSM prevention program	595,999	0[a]	505,241
Allocation to needle-syringe program	1,275,822	1,432,702	1,312,379
Allocation to opiate substitution therapy	730,636	730,636	730,636
Allocation to HIV counselling and testing	787,196	528,597	876,446
Allocation to PMTCT	902,884	0[b]	0[b]
Allocation to antiretroviral therapy	925,307	2,838,933	3,455,145
Total annual direct program spending	5,530,868	5,530,868	6,879,847
Total for management and other costs	7,061,570	7,061,570	5,649,256
Total annual HIV spending	12,592,438	12,592,438	12,592,438
Total (cumulative) direct program spending, 2015–20	33,810,554	34,976,493	43,507,968
Cumulative new infections, 2015–20	6,500	4,700	3,900
Cumulative AIDS-related deaths, 2015–20	3,800	1,800	1,600
Cumulative DALYs, 2015–20	52,300	45,200	43,900
Overall prevalence, 2020 (%)	0.17	0.17	0.17
Number of people living with HIV, 2020	10,200	10,500	10,000
New infections averted, 2015–20	Baseline	1,800	2,600
AIDS-related deaths averted, 2015–20	Baseline	2,000	2,200
DALYs averted, 2015–20	Baseline	7,100	8,400

Source: Populated Optima model for the Kyrgyz Republic.
Note: a = As explained in the narrative, these programs remain important from an epidemiological point of view and should continue to be provided, which could be achieved either by increasing overall funding for the HIV response or by reducing unit costs of these programs; b = As explained in the narrative in more detail, pregnant women should continue to be covered with ART as part of the increased ART budget. In practice, continued access to ART for pregnant women, also would require continued HIV testing and counselling for pregnant women, which could be funded out of the general HTC program, or out of maternal health budgets.

At the same time, since eliminating MTCT is regarded as a separate national target and since sexual transmission declined only moderately, Allocation C would not fully achieve the national targets, which are further explored in chapter 7. If the HIV response budget cannot be increased to fully achieve national targets, as explored in chapter 7, either PMTCT unit cost would need to be reduced, or costs for HIV prevention among pregnant women could be covered from maternal health budgets.

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6. WHAT MIGHT BE GAINED FROM INCREASED FUNDING AND WHAT SHOULD BE PRIORITIZED WITH REDUCED FUNDING?

This analysis considers what could be gained by increasing the HIV budget from the 2013 levels and which programs would have the largest impact if less funding were available and the response would need to be further prioritized. Optimized allocations to programs and corresponding impact for different levels of funding ranging from 0 percent of 2013 spending to 200 percent of 2013 spending are compared in this analysis.

Although the likelihood is small that the country will immediately move to 0 percent or 200 percent of funding, this analysis is helpful in understanding an epidemic's dynamics in relationship to the level of programmatic investments. First, it shows which services are the most essential in case of crisis. Second, it shows to what extent the same impact could be achieved with less funding. Third, it illustrates whether additional investment would lead to saturation of impact or whether large additional gains could be made with additional investment. Finally, scenarios in which higher coverage and impact are achieved with more funding also are useful as a starting point for discussing implementation efficiency: how to achieve the same coverage and impact with less funding.

This optimization analysis was conducted for minimizing both HIV incidence and AIDS-related deaths by 2020 and the same weight was given to a new infection and a death averted.[10] Figure 6.1 shows optimized allocations and the corresponding combined effect on new infections and deaths. In optimized allocations with very low levels of funding, programs for PWID are the focus of investment. In contrast, with reduced funding at the level 80 percent of current spending and with increased funding, ART moves into the focus of additional investment. In practical terms, retaining everyone who already is on ART and OST also would be a critical priority and factored in for any allocation scenario. With levels of investment of 140 percent and above, more HTC is required for increasing ART coverage and additional prevention investment for PWID and MSM gets prioritized.

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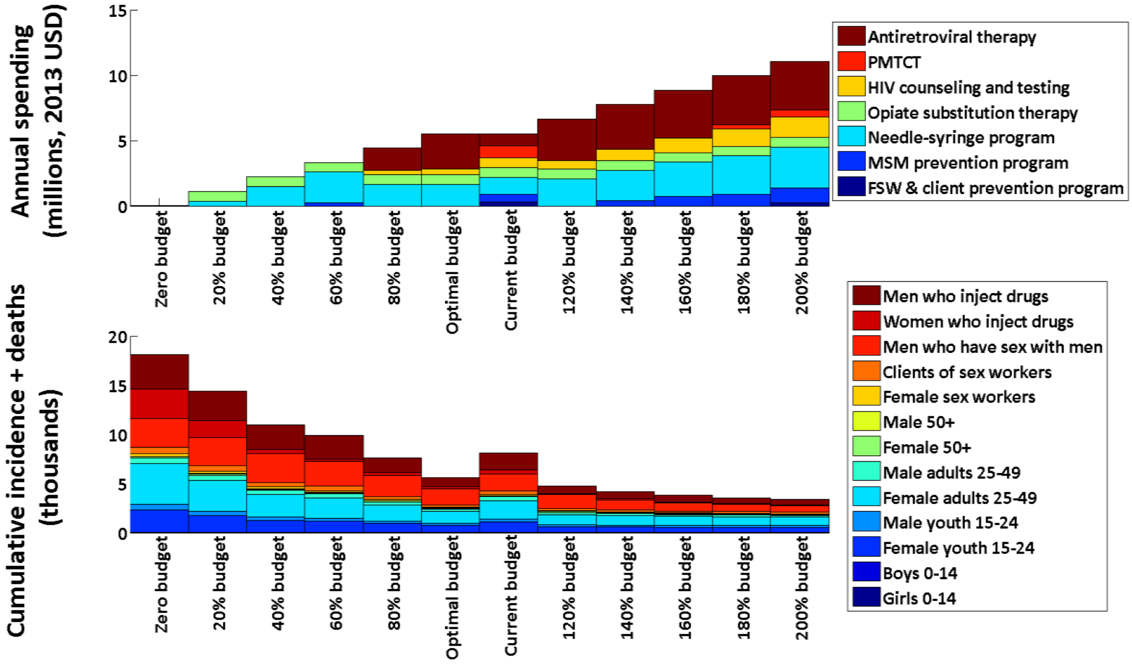
10 An allocation that attempts to minimize incidence and deaths simultaneously with equal weights and a fixed amount of money would be influenced by the country-specific cost for treatment and prevention programs. More commonly, cost for averting new infections is lower than cost for averting death. Hence, in these cases, optimization will avert more new infections than deaths. However, the dual effect of ART on new infections and deaths reduces this potential bias. Conversely, minimizing DALYs is likely to be more biased toward reducing deaths as a death implies a DALY of 1, while a person living with HIV has a DALY of 0.221, rising to 0.547 in the AIDS stage.

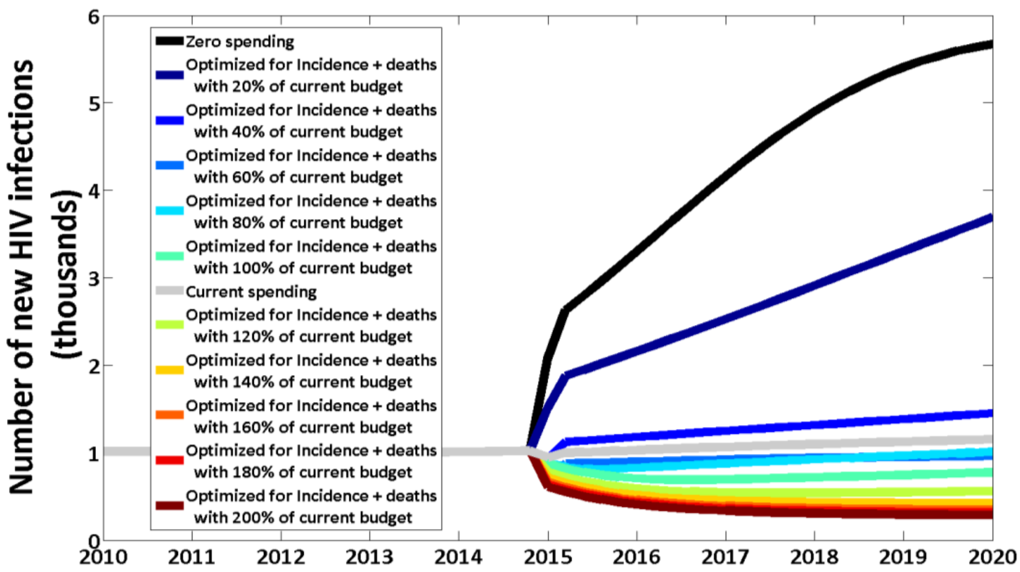
Figure 6.1 Spending allocations for varying budgets to minimize cumulative HIV incidence plus AIDS-related deaths, 2015–20



Source: Populated Optima model for the Kyrgyz Republic.

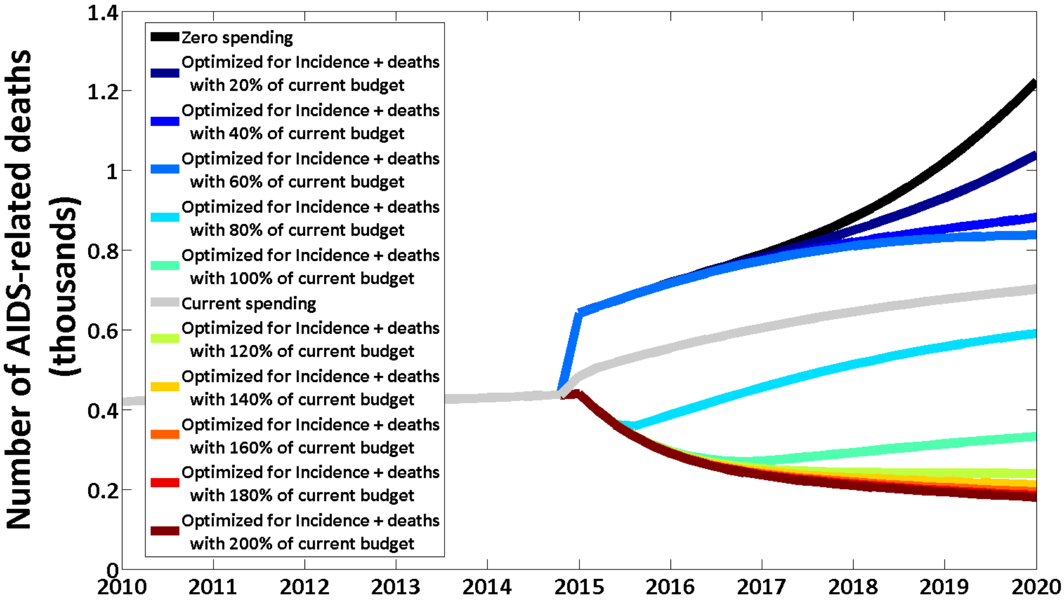
Figure 6.2 and Figure 6.3 track the effects of these allocations on new infections and deaths separately. The effects of allocating current spending were discussed in the previous chapter. Figure 6.2 and Figure 6.3 illustrate that, with optimized allocations for 80 percent of current spending, new infections and deaths both would remain below current levels. In terms of reducing HIV incidence (Figure 6.2), there is a particularly large effect of sustaining at least minimal investment into prevention programs for PWID, particularly NSP, in the absence of which new infections would rise dramatically. Optimized allocations up to 140 percent of current spending would decrease HIV incidence by approximately 60 percent as compared to current allocations. For minimizing deaths, optimized allocations for 120 percent of current spending already would reduce deaths by nearly 67 percent.

Figure 6.2 Total number of new infections under each of the varying budgets, 2010–20



Source: Populated Optima model for *the Kyrgyz Republic*.

Figure 6.3 Total number of AIDS-related deaths under each of the varying budgets, 2010–20



Source: Populated Optima model for the Kyrgyz Republic.

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7. HOW MUCH WILL IT COST TO ACHIEVE THE TARGETS OF THE NATIONAL HIV STRATEGIC PLAN?

This analysis identifies the minimum resource requirements to fully achieve the national strategy targets. The analyses in chapter 5 assumed fixed amounts of available funding and explored an optimized allocation of those funds to minimize new infections and deaths with the current budget. In chapter 6, the analyses explored the likely gains from increased and reduced investment in the HIV response. In contrast, the analysis in chapter 7 aims for the **full achievement of the national strategy targets**, and determines the minimum budget required to achieve those goals. This analysis assesses the gap in funding required to achieve the national strategy targets.

7.1 Exploring technical efficiency to reduce the cost to achieve national targets

The estimated cost to achieve national targets with current costs per person reached and the current proportion of costs going to management and other costs would be $24 million (appendix D) and thereby would nearly double the HIV investment. Since such a high level of investment might not be realistic to achieve in a resource-constrained environment with many competing health priorities, the potential contribution of other efficiency gains was explored.

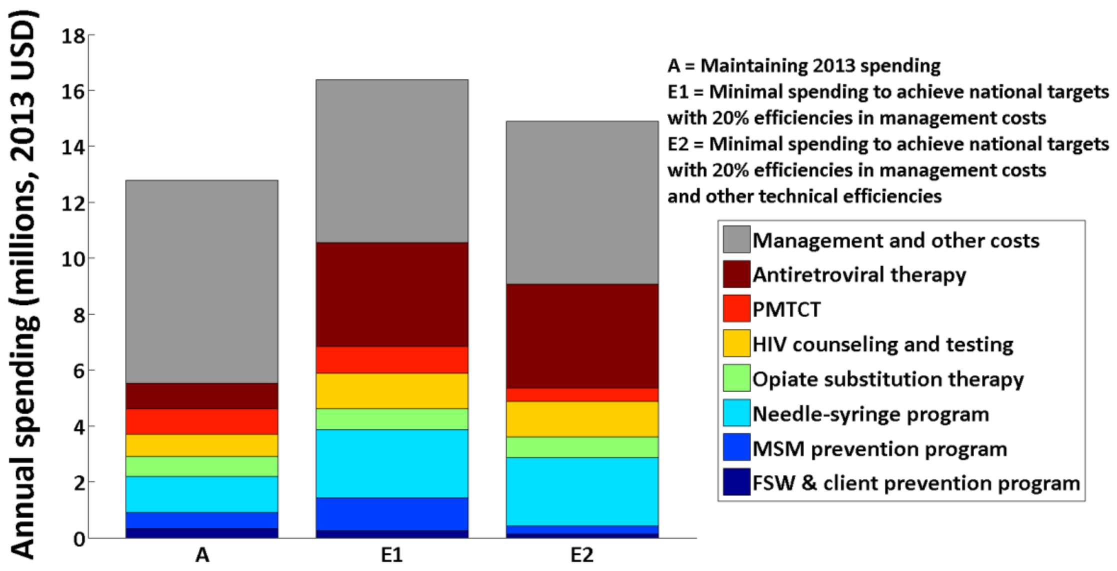
Figure 7.1 shows the total cost to achieve national targets by 2020 with 2 scenarios. They combine allocative efficiency analysis with specific technical efficiency assumptions applied to the allocation to fully achieve national targets.

Allocation B shows current allocations. Allocation E1, shows the optimized distribution of funding to achieve national targets, assuming that management and other costs are not increased proportionately but rather are reduced by 20 percent.[11] A 20 percent cost reduction was used as an estimate that could be achieved through technical efficiencies while maintaining core management functions and enablers. Allocation E2 represents the optimized allocation to achieve national targets (50 percent reduction in HIV incidence and deaths by 2020). Allocation E2 assumes technical efficiency gains in 3 programs, which are needed to fully achieve national targets but have not been cost effective in allocation scenarios that use current funding. These are programs for FSW, MSM, and PMTCT. For them, costs per person reached in the Kyrgyz Republic also were substantially above the median cost in other countries of the Region. Therefore, 50 percent reductions in costs for FSW and PMTCT

[11] 20 percent was used as an estimate for a reduction in costs excluded from optimization, which could be achieved through efficiencies without putting at risk major management functions and synergies. The potential reduction by 20 percent is roughly equivalent to the level of allocative efficiency gains for programs included in the mathematical optimization, because at 80 percent of 2013 funding results would not be compromised if resources are allocated optimally. As elaborated above (chapter 6, optimized allocation with 80 percent of current budgets), optimization was able to compensate for a 20 percent reduction in program resources.

programs were assumed, and a 75 percent reduction in cost per person reached in MSM programs. These reductions may appear very high, particularly for MSM programs. However, even with a 75 percent reduction, the cost per person reached in MSM programs (US$449 reduced to US$112) would remain above the median cost of the other 6 countries included in the analysis.

Figure 7.1 Optimized allocation to achieve 2020 national targets: Technical efficiencies can further reduce the cost for achieving national targets



Source: Populated Optima model for the Kyrgyz Republic.

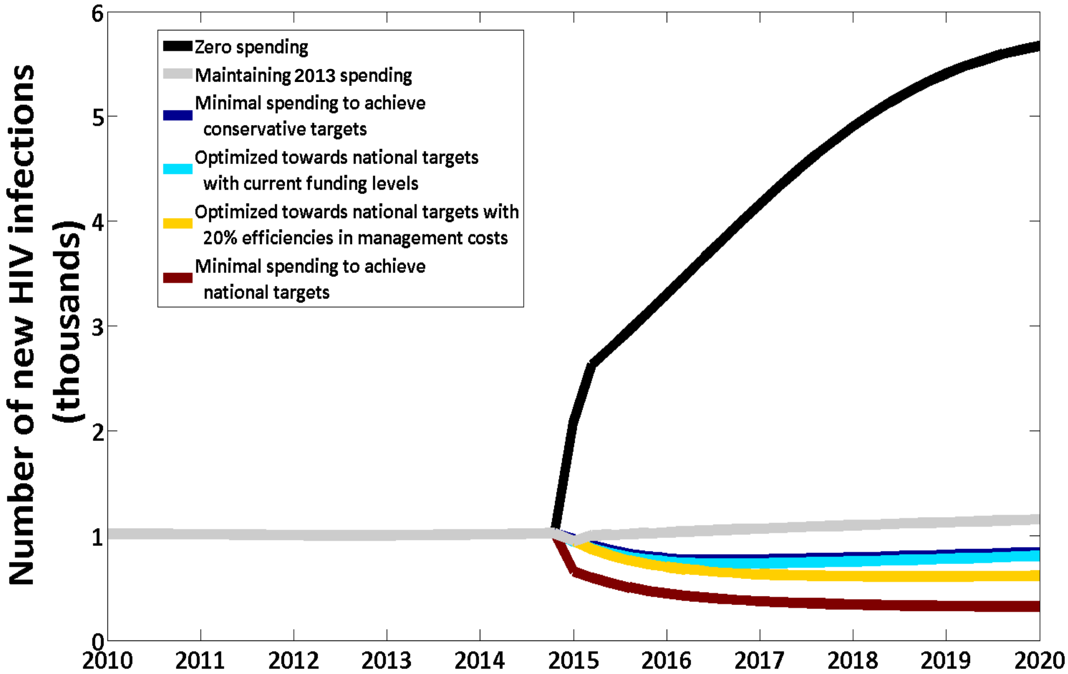
With the assumed reductions in management and other cost, national targets could be achieved with approximately $16 million. This amount could be reduced further to approximately US$15 million with the proposed reductions in unit costs for FSW, MSM, and PMTCT programs. By exploring technical efficiencies in other programs, it might be possible to reduce further the cost for achieving national targets.

7.2 Health outcomes for different scenarios

Figures 7.2 to 7.6 show the key epidemiological outcomes over time under each of the key allocation scenarios.

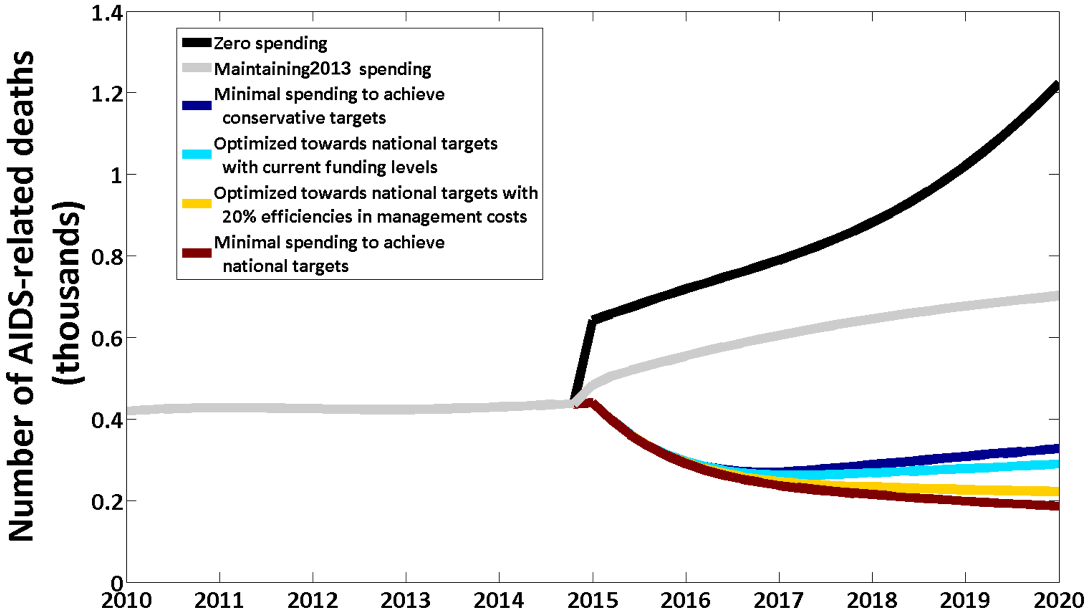
- The **black line** represents outcomes for zero spending.
- The **gray line** shows effects for maintaining current spending and distribution of resources among programs (US$12.6 million).
- The **blue line** shows effects for conservative targets: no increase in incidence and deaths (US$13.3 million).
- The **turquoise line** shows the effect of current spending optimized *toward* national targets (US$12.6 million).
- The **yellow line** shows the effect of current spending optimized *toward* national targets with 20 percent reduction in management costs. (US$12.6 million).
- The **brown line** represents the key result: optimized allocations to *achieve* national targets. (US$24 million at current unit and management costs, $16 million with reduced management cost, US$15 million with specific additional technical efficiencies).

Figure 7.2 Total number of new HIV infections, 2010–20



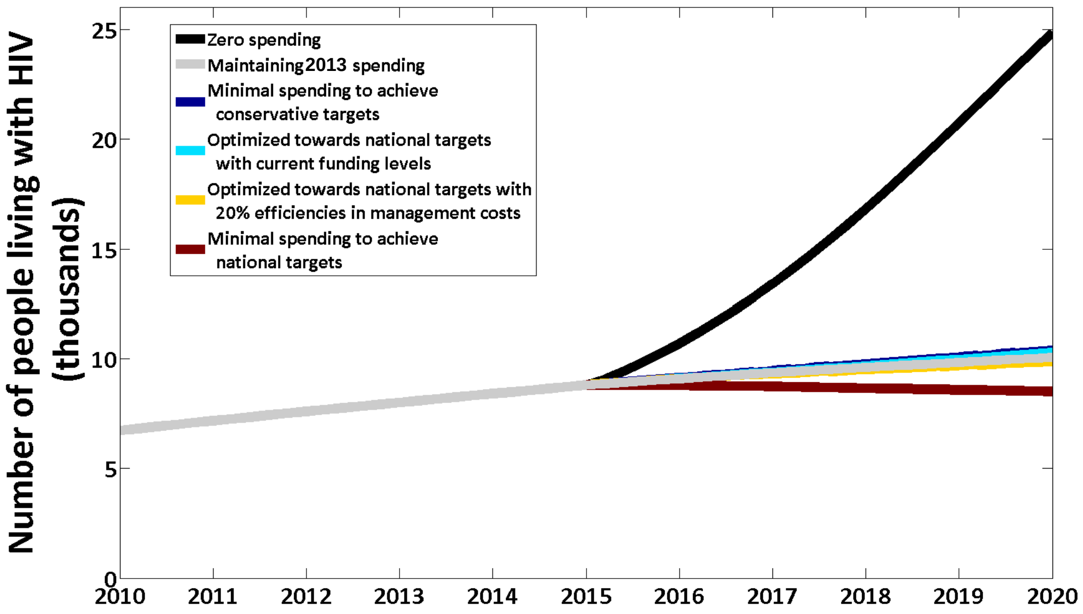
Source: Populated Optima model for the Kyrgyz Republic.

Figure 7.3 Total number of AIDS-related deaths, 2010–20



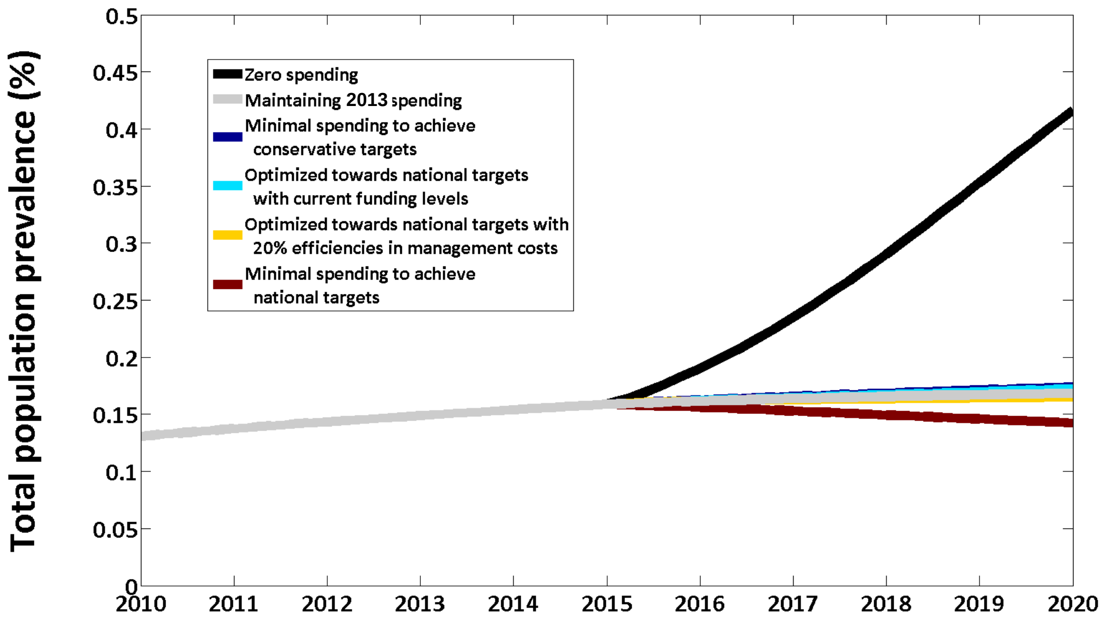
Source: Populated Optima model for the Kyrgyz Republic.

Figure 7.4 Total number of people living with HIV, 2010–20



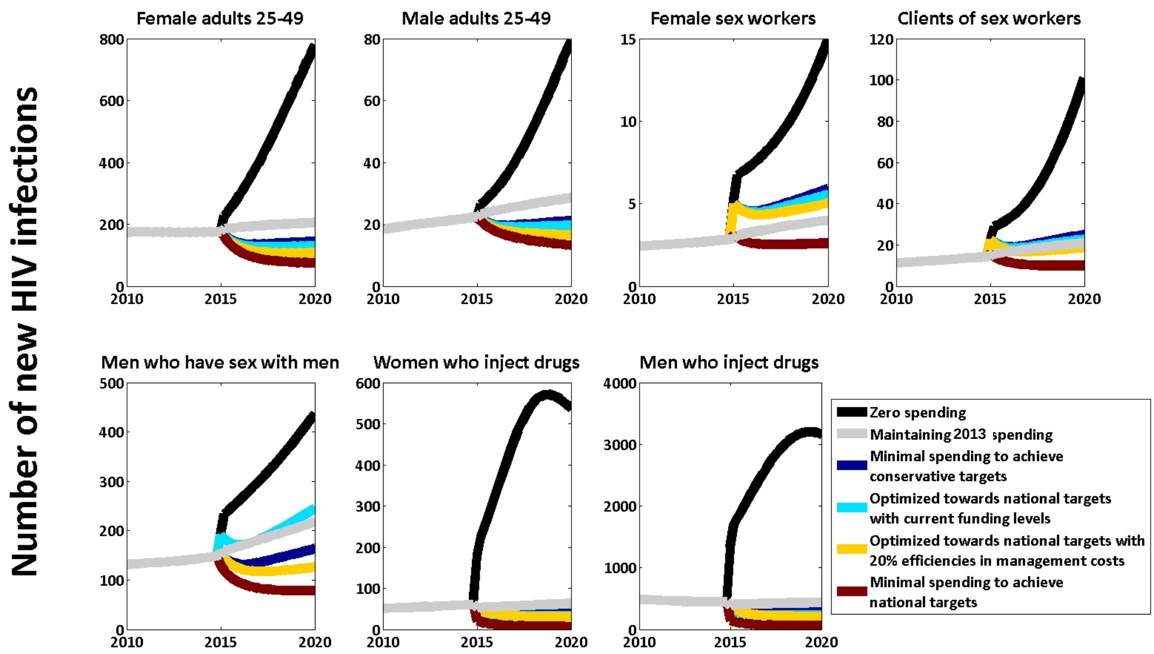
Source: Populated Optima model for the Kyrgyz Republic.

Figure 7.5 Total population prevalence, 2010–20



Source: Populated Optima model for the Kyrgyz Republic.

Figure 7.6 Number of new HIV infections by population group, 2010–20



Source: Populated Optima model for the Kyrgyz Republic.

Table 7.1 shows the cost to achieve national targets with 20 percent efficiencies in management cost, the corresponding program coverage levels, and epidemic epidemiological outcomes.

Table 7.1 Program coverage levels, epidemiological outcomes, and cost-effectiveness calculations relating to the spending scenarios described

Analysis to end of 2020	**Maintaining 2013 spending**		**Minimal spending (average per year between 2015-20) to achieve national targets with 20% efficiencies in management costs**	
Annual allocations between 2015-20 (average)	**(US$)**	**%**	**(US$)**	**%**
Allocation to FSW and client prevention program	313,024	2	261,129	2
Allocation to MSM prevention program	595,999	5	1,167,539	7
Allocation to needle-syringe program	1,275,822	10	2,452,339	15
Allocation to opioid substitution therapy	730,636	6	730,636	5
Allocation to HIV counselling and testing	787,196	6	1,262,520	8
Allocation to PMTCT	902,884	7	966,953	6
Allocation to antiretroviral therapy	925,307	7	3,722,841	23
Total annual direct program spending	5,530,868	44	10,563,957	65
Total for management and other costs	7,061,570	56	5,649,256	35
Total annual HIV spending	12,592,438	100	16,213,213	100
FSW and client prevention program coverage (%)		40		34
MSM prevention program coverage (%)		8		13
Needle-syringe program coverage (%)		42		56
Opioid substitution therapy program coverage (%)		4		4

Table 7.1 Program coverage levels, epidemiological outcomes, and cost-effectiveness calculations relating to the spending scenarios described *(Continued)*

Analysis to end of 2020	**Maintaining 2013 spending**	**Minimal spending (average per year between 2015-20) to achieve national targets with 20% efficiencies in management costs**
Annual allocations between 2015-20 (average)	**%**	**%**
People living with HIV who know their status (%)	63	83
PMTCT program coverage (%)	89	>90
Antiretroviral therapy coverage (eligibility: <500 dx) (%)	33	>90
Antiretroviral therapy coverage (eligibility: <350 dx) (%)	43	>90
Those on treatment who are virally suppressed (%)	87	87
Number on 1st-line treatment	1,500	6,400
Number on 2d-line treatment	100	300
Number eligible for treatment (eligibility: <500 dx)	4,800	6,900
Number eligible for treatment (eligibility: <350 dx)	3,800	6,800
Cumulative new infections, 2015–20	6,500	2,300
Cumulative AIDS-related deaths, 2015–20	3,800	1,400
Cumulative DALYs, 2015–20	52,300	42,300
Overall prevalence, 2020 (%)	0.17	0.14
Number of people living with HIV, 2020	10,200	8,500
New infections averted, 2015–20	Baseline	4,200
AIDS-related deaths averted, 2015–20	Baseline	2,300
DALYs averted, 2015–20	Baseline	10,000

Source: Populated Optima model for the Kyrgyz Republic.

Achieving the national targets would translate to averting 4,200 (65 percent) new infections and 2,300 (62 percent) deaths.[12]

7.3 Cost-effectiveness of allocation scenarios

The cost-effectiveness calculations discussed in this section compare to a baseline of *zero spending* from 2015 on. In the zero spending scenario from 2015 to 2020, an estimated 27,200 cumulative new HIV infections and 5,600 cumulative AIDS-related deaths would occur in the Kyrgyz Republic. Under zero spending from 2015 to 2030, the epidemic is projected to increase such that an estimated 94,500 cumulative new HIV infections and 37,000 cumulative AIDS-related deaths occur.

Under a scenario of maintaining current spending and distribution to programs, an estimated 20,700 of the 27,200 new infections could be averted by 2020, and 1,800 of the 5,600 AIDS-related deaths could be averted. By 2030, maintaining current spending could avert 75,000 of the 94,500 new infections and 25,100 of the 37,000 AIDS-related deaths.

When current funding is maintained, the program costs (excluding management) between 2015 and 2020 total $33,810,554. This total implies that the cost per infection averted in

12 Achieving all 3 targets for reducing new sexual infections by 50 percent, new injecting infections by 50 percent, and virtually eliminating MTCT cumulatively leads to higher overall reductions in new infections and deaths. The reason is that the effects of individual interventions such as ART required to achieve one target have additional effects on others.

maintaining the current spending scenario would be $1,634 and the cost per death averted would be $18,420. When considering maintaining current funding for the longer 2015–30 time frame, compared to the baseline scenario of zero spending, the cost per infection averted would be $1,229 and the cost per AIDS-related death averted would be $3,665.

By achieving 20 percent efficiencies in "management and other costs" activities and reallocating all program funds toward achieving the national targets (Allocation E of Figure E.2 Optimizing spending toward national targets and to achieve national targets by 2020), when compared to the zero-spend baseline, 23,300 new infections and 4,000 AIDS-related deaths could be averted by 2020 (Table 7.2). Compared to the maintaining current spending projection, the optimized spending would equate to averting an additional 2,600 new infections and, significantly, 2,200 AIDS-related deaths by 2020. By 2030, optimally redistributing current funding levels toward the national strategic targets while achieving 20 percent efficiencies in "management and other costs" activities could avert an estimated 85,400 new infections and 27,600 deaths––that is, 10,500 infections and 2,500 deaths fewer than the maintaining current spending scenario.

By optimally allocating toward national targets while achieving 20 percent efficiencies in "management and other costs" activities, the cost per infection averted by 2020 is $1,868, and the cost per death averted is $10,751. The cost per AIDS-related death averted in this scenario is $7,729 less than in the scenario of maintaining current spending.

In all the different scenarios for 2020 and 2030, the HIV response remains highly cost effective. Further expanding coverage––although it would imply covering more hard-to-reach segments within key populations––still would be cost effective, particularly with the longer 2030 horizon.

Table 7.2 Impact and cost-effectiveness of the Kyrgyz Republic's HIV programs

Impact measures	Maintain 2013 spending*	Optimized toward national targets with 20% efficiencies in management costs	Minimized spending to achieve national targets with 20% efficiencies in management costs
Number of new HIV infections averted by 2020	20,697	23,285	24,930
Cost per infection averted by 2020 (US$)	1,634	1,868	2,587
Number of AIDS-related deaths averted by 2020	1,830	4,047	4,157
Cost per death averted by 2020 (US$)	18,480	10,751	15,515
Number of new HIV infections averted by 2030	74,950	85,425	89,361
Cost per infection averted by 2030 (US$)	1,229	1,256	2,076
Number of AIDS-related deaths averted by 2030	25,121	27,626	33,972
Cost per death averted by 2030 (US$)	3,665	3,885	5,462

Source: Populated Optima model for the Kyrgyz Republic.
Note: * = It could appear counter-intuitive that the cost per new infection averted is lower for maintaining 2013 spending compared to optimized allocations. Two factors explain this: First, compared to zero spending, the first new infections could be averted at lower cost through relatively low-cost programs such as NSP. Extending the coverage of other programs comes at additional cost and makes averting new infections more expensive. Second, only direct program costs were included here. In other words, even though the 20% reduction in management cost would increase the proportion of money going into programs, that reduction was not part of the numerator (total cost to be divided by deaths/new infections averted).

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8. CONCLUSIONS AND RECOMMENDATIONS

The range of analyses both suggests a number of common trends and has different implications for understanding the epidemic, policies, and program implementation. The main conclusions and recommendations arising from the findings of this study are presented below.

1 **HIV in the Kyrgyz Republic is transitioning from an early concentrated epidemic among PWID into an advanced concentrated epidemic characterized by continued transmission among PWID but an increasing share of sexual transmission to female partners of PWID and among MSM.** Optima projects, from 2015–20, transmission just below 50 percent and MTCT at approximately 2 percent, assuming current coverage and behavior. Under current conditions, the estimated average annual 1,000 new infections in 2014 are projected to increase to 1,100, and average annual deaths to rise from 400 in 2014 to 600 in 2015–20. The total estimated number of PLHIV would increase from 8,400 to 10,200. This projected increase suggests that there is continued need to scale up programs as specified in recommendations III to VIII.

2 **Investment in HIV programs in the Kyrgyz Republic is substantial, and current programs prevent a large expansion of the epidemic.** With a total of US$12.6 million in 2013, HIV spending in the Kyrgyz Republic equates to approximately US$1,500 per PLHIV, one of the highest values in the Region. An analysis comparing the effect of current programs to a scenario of zero HIV spending revealed that current programs would avert 20,700 new infections and 1,800 deaths. This analysis clearly suggests that harm reduction focused on PWID in combination with other current programs continues to prevent more rapid spread of HIV among PWID. In the absence of programs, this spread is projected to occur in large numbers through increased needle-sharing. The prospect of a more than three-fold growth in the PLHIV population by 2020 in the absence of any HIV programs suggests that HIV investment needs to be extended to 2020 and beyond to 2030 to contain the epidemic and to meet national targets and international commitments.

3 **Optimizing allocations of currently available resources would substantially reduce new HIV infections by 28 percent and deaths by 53 percent from 2015–20.** Optimization analysis suggests that this additional impact would be achieved mainly by reallocating resources to 2 program areas: a 3-fold increase in investment in ART accompanied by sustained HTC and a moderate increase in prevention programs for PWID, particularly needle-exchange programs. Despite the large efficiency gains through reallocations, national targets cannot be fully achieved with current resources at current unit costs.

The following recommendations focus on the prioritization required to achieve national targets: reducing sexual transmission by 50 percent, reducing drug-injection-related transmission by 50 percent, virtually eliminating MTCT by 2020, and reducing AIDS-related deaths by 50 percent.

4 **The top priority in the Kyrgyz Republic's HIV response is to substantially increase the allocation to and coverage of antiretroviral therapy.** In 2013 only 7 percent of total national HIV spending was allocated to ART. Coverage of 1,074 PLHIV on ART was achieved in 2013, which is approximately 13 percent of the total estimated PLHIV, or 43 percent of the PLHIV eligible for ART at the time. With optimized allocations to fully achieve national targets, investment in ART would increase from US$0.9 million to US$3.7 million accompanied by increased investment in HTC from US$0.8 million to US$1.3 million, totaling $5.0 million, or 31 percent of all HIV spending. This level of spending would extend ART coverage to 6,700 PLHIV, or 79 percent of all PLHIV.[13] Compared to current spending, this coverage would dramatically reduce deaths by 62 percent (avert 2,300 deaths) over 2015–20.

5 **The second priority in the Kyrgyz Republic's HIV epidemic is sustaining and expanding coverage of programs for PWID.** The share of new infections due to needle-sharing is declining and accounts for slightly less than 50 percent of new infections. However, programs for this group remain critical due to the large potential for epidemic growth among PWID in the absence of programs. Optimization analysis suggests that, if resources were reduced, PWID programs should be a focus of the HIV response. With allocations optimized to achieve national targets, programs for PWID would receive 20 percent of all funding, or US$3.2million (up from US$2.0 million), compared to current allocations. In practical terms, it will be critical to review unit costs of NSP and OST programs for savings to increase not only NSP coverage as suggested by optimization, but also OST program coverage. OST programs have multiple health and social benefits, and current coverage of 4 percent is insufficient to realize them. It, therefore, will be essential for the Kyrgyz Republic to identify non-HIV resources from health and social sector budgets to cofinance the scale-up of OST.

6 **HIV transmission among MSM is a small, but also the fastest growing, segment of the Kyrgyz Republic's HIV epidemic. Consequently, to achieve national targets, focused technically efficient programs for MSM should continue to be provided.** At current unit cost, to virtually double coverage, an increase in budgets from US$0.6 million to US$1.2 million would be required. However, the exceptionally high cost per person reached (US$449) suggests that there may be large potential for technical efficiency gains. Considering the cost of other programs with similar packages and programs in other countries, a 65 percent to 85 percent reduction might be realistic and should be explored further through technical efficiency analysis.

7 **Female sex workers and their clients contribute to fewer than 1 in 20 new infections in the Kyrgyz Republic. In this context, technical efficiency of programs should be reviewed to enhance their cost-effectiveness.** If current or reduced funding is available, at current unit cost, FSW programs would not be part of the optimized mix of programs. However, if full funding to achieve national targets by 2020 were available, to fully achieve the target of reducing sexual transmission by half, programs for FSW would need to be sustained at current levels of coverage. The estimated allocation to achieve national targets of US$0.3 million (2 percent of the total allocation) could be reduced by exploring technical efficiency gains. Comparing Kyrgyz' cost per person reached to that of other countries, substantial reductions by up to 50 percent could be feasible. This reduction also could be achieved by doubling coverage without increasing total FSW program cost, which likely would require a strong focus on key locations so that economies of scale could be achieved in these settings.

13 With optimized allocations to achieve national targets, the projected number of PLHIV in 2020 would be 8,500.

8 **HTC and ART should remain available to pregnant women to reduce MTCT but at the lowest possible cost.** Just as with FSW and MSM programs, PMTCT programs would not be part of the optimized mix of programs at current unit cost for current levels of spending. Moreover, MTCT accounts for approximately only 2 percent of new infections. Because the national strategy includes an exclusive MTCT target, the optimized allocation includes an amount of US$1.0 million for PMTCT, but additional technical efficiencies should be explored.

9 **It is essential to critically study the large portion of HIV spending (56 percent) allocated to management and other costs because reallocating 20 percent of these costs to core treatment and prevention programs would avert additional new infections and deaths.** Even though blood safety and STI management were excluded from the analysis, management, and other costs still accounted for 56 percent of HIV spending. Because this expenditure could not be reviewed in the optimization analysis, other methods of technical efficiency analysis should be applied to explore potential savings.

10 **The minimum amount to achieve national targets with optimized allocations is US$24 million, which could be substantially reduced to US$16 million through reducing management cost, and further through exploring technical efficiency gains.** Achieving national targets in the Kyrgyz Republic would avert 2,300 deaths and 4,200 new infections. The amount needed to achieve these targets depends heavily on critical choices that the Kyrgyz Republic needs to make. With business as usual (current allocations, current unit costs), it would cost US$43 million annually. If management and other costs grow proportionately to direct program costs, with optimized allocations, the amount can be reduced to US$24 million. If management and other costs do not grow but could be cut by 20 percent compared to 2013, the cost to achieve national targets would be US$16 million. With additional potential efficiency gains in FSW, MSM, and PMTCT programs, as identified by country experts (and described in section 7.1), the amount could be reduced to US$15 million. Technical efficiency of core programs should be studied.

11 **A robust national process to review technical efficiency, costing, and financing of the national HIV response could result in a detailed plan to close the financing gap and achieve national targets. This costed plan could outline how to realize allocative and technical efficiency gains and mobilize domestic resources for the response.** Regional comparison of cost per person reached suggests that, in virtually all programs, there may be additional technical efficiencies in the range of 20 percent to 50 percent that would bring the estimated cost to achieve national targets closer to the US$12.6 million available in 2013. The relatively large differences in cost over different years and by program suggest that setting benchmarks for unit costs and strengthening monitoring of cost-efficiency in delivery are key priorities in the management of the national HIV response.

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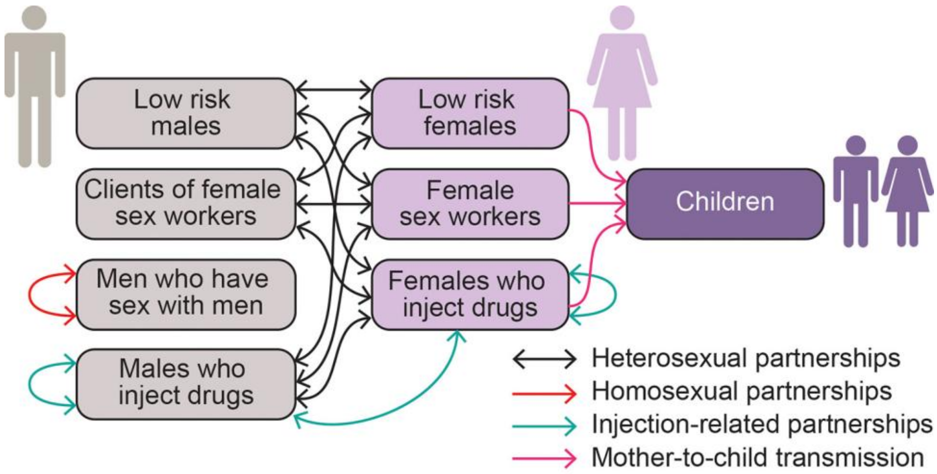
APPENDIXES

APPENDIX A. TECHNICAL SUMMARY OF OPTIMA

Appendix A provides a brief technical overview of Optima. A more detailed summary of the model and methods is provided elsewhere (Kerr and others 2015). Optima is based on a dynamic, population-based HIV model. Figure A.1a summarizes the populations and mixing patterns used in Optima. Figure A.1b shows the disease progression implemented in the model. Optima tracks the entire population of people living with HIV (PLHIV) across 5 stages of CD4 count. These CD4 count stages are aligned with the progression of the World Health Organization (WHO) treatment guidelines, namely, acute HIV infection, >500, 350–500, 200–350, 50–200, and 50 cells per microliter. Key aspects of the antiretroviral therapy (ART) service delivery cascade are included: from infection to diagnosis, ART initiation on first-line therapy, treatment failure, subsequent lines of therapy, and HIV/AIDS-related or other death.

Figure A.1a Example population groups and HIV transmission-related interactions in Optima



Source: Graphic prepared by UNSW study team.

The model uses a linked system of ordinary differential equations to track the movement of PLHIV among HIV health states. The full set of equations is provided in the supplementary material to a summary paper on the Optima model. The overall population is partitioned in two ways: by population group and by HIV health state. Individuals are assigned to a given population group based on their dominant risk.[14] HIV infections occur through the interactions among different populations by regular, casual, or commercial (including transactional) sexual partnerships; through sharing of injecting equipment; or through mother-to-child transmission. The force-of-infection is the rate at which uninfected individuals become infected. The rate depends on the number and type of risk events to which individuals are exposed in a given period (either within their population groups or through interaction with other population groups) and the infection probability of each event. Mathematically, the force of- infection has the general form:

$$\lambda = 1 - (1 - \beta)^{n},$$

where λ is the force-of-infection, β is the transmission probability of each event, and n is the effective number of at-risk events (that is, n gives the average number of interaction events with HIV-infected people through which HIV transmission may occur). The value of the

14 However, to capture important cross-modal types of transmission, relevant behavioral parameters can be set to non-zero values (for example, males who inject drugs may engage in commercial sex; some MSM may have female sexual partners).

transmission probability β varies across CD4 count compartments (indirectly reflecting the high viral load at early and late stages of infection); differs for different modes of transmission (intravenous drug injection with a contaminated needle-syringe, penile-vaginal or penile-anal intercourse, and mother-to-child); and may be reduced by behavioral interventions (for example, condom use), biological interventions (for example, male circumcision), or ART. There is one force-of-infection term for each type of interaction, for example, casual sexual relationships between male sex workers and female sex workers (FSW). The force-of-infection for a given population will be the sum of all interaction types.[15] In addition to the force-of-infection rate, which is the number of individuals who become infected with HIV per year, there are seven other ways by which individuals can change health states.[16] The change in the number of people in each compartment is determined by the sum over the relevant rates described above multiplied by the population size of the compartments on which they act.[17]

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[15] For sexual transmission, the force-of-infection is determined by:

- HIV prevalence (weighted by viral load) in partner populations
- Average number of casual, regular, and commercial homosexual and heterosexual acts per person per year
- Proportion of these acts in which condoms are used
- Proportion of men who are circumcised
- Prevalence of sexually transmissible infections (which can increase HIV transmission probability)
- Proportion of acts that are covered by pre-exposure prophylaxis and post-exposure prophylaxis
- Proportion of partners on antiretroviral treatment (art)
- Efficacies of condoms, male circumcision, post-exposure prophylaxis, pre-exposure prophylaxis, and art at preventing HIV transmission.

For injecting-related transmission, the force-of-infection is determined by:

- HIV prevalence (weighted by viral load) in populations of people who use a syringe and then share it
- Number of injections per person per year
- Proportion of injections made with shared equipment
- Fraction of people who inject drugs on opioid substitution therapy and its efficacy in reducing injecting behavior.

For mother-to-child transmission, the number of-infections is determined by:

- Birth rate among women living with HIV
- Proportion of women with HIV who breastfeed
- Probability of perinatal HIV transmission in the absence of intervention
- Proportion of women receiving prevention of mother-to-child transmission (PMTCT), including ART.

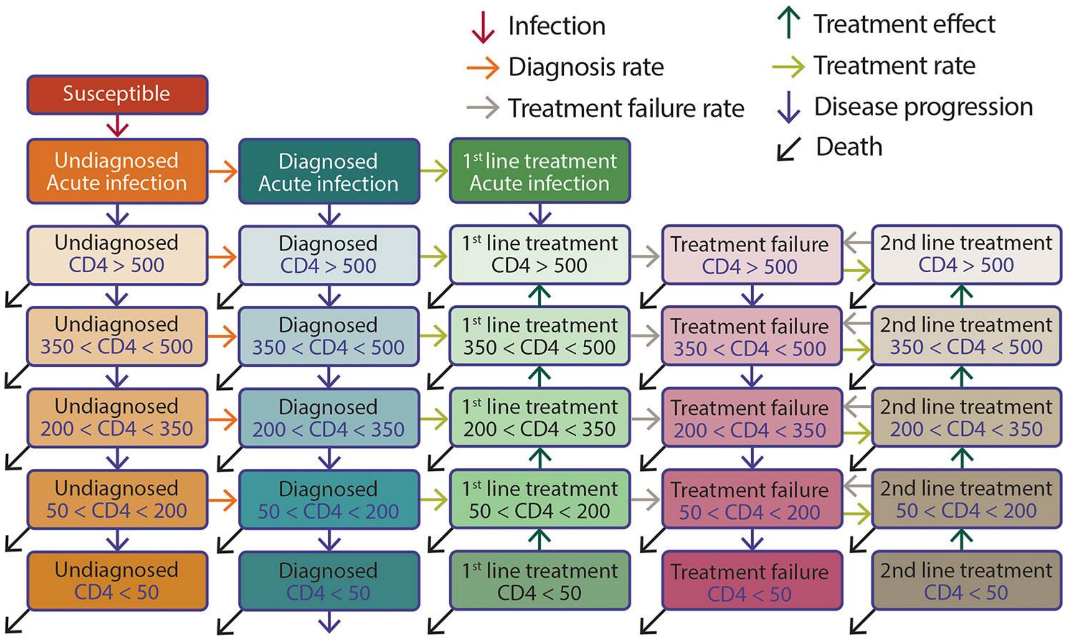
[16] First, individuals may die, either because of an average background death rate for that population (which is greater for older populations or for people who inject drugs) or because of HIV/AIDS (which depends on CD4 count). Second, in the absence of treatment, individuals progress from higher to lower CD4 counts. Third, individuals can move from undiagnosed to diagnosed states based on their HIV testing rate, which depends on CD4 count (for example, people with AIDS symptoms or primary HIV infection may have a higher testing rate) and population type (for example, FSW may test more frequently than males in the general population). Fourth, diagnosed individuals may commence ART at a rate depending on CD4 count. Fifth, individuals may experience treatment failure due to lack of adherence to therapy or development of drug resistance. Sixth, people may initiate second and subsequent lines of treatment after treatment failure. Finally, while on successful first- or second-line treatment (that is, effective viral suppressive therapy), individuals may progress from lower to higher CD4 counts.

[17] For example, the change in the number of undiagnosed HIV-positive FSW with a CD4 count between 200–350 cells per microliter is:

$$\frac{dU_{\mathrm{FSW}_{200-350}}}{dt} = U_{\mathrm{FSW}_{350-500}} \tau_{350-500} - U_{\mathrm{FSW}_{200-350}} \left(\mu_{200-350} + \tau_{200-350} + \eta_{\mathrm{FSW}_{350-500}} \right),$$

where UFSW2002350 is the current number of undiagnosed HIV-positive FSW with a CD4 count between 200–350 cells per microliter; UFSW3502500 is the same population but with higher CD4 count (350–500 cells/mL); t is the disease progression rate for the given CD4 count (where 1/t is the average time to lose 150 CD4 cells/mL); m is the death rate; and h is the HIV testing rate. (Note: This example does not consider movement among populations, such as FSW returning to the general female population and vice versa—something which is included in Optima.)

Figure A.1b Schematic diagram of the health state structure of the model



Source: Figure prepared by UNSW study team.
Note: Each compartment represents a single population group with the specified health state. Each arrow represents the movement of numbers of individuals among health states. All compartments except for "susceptible" represent individuals living with HIV. Death includes all causes of death.

Each compartment (Figure A.1b, boxes) corresponds to a single differential equation in the model, and each rate (Figure A.1b, arrows) corresponds to a single term in that equation. Table A.1 lists the parameters used in Optima; most of these are used to calculate the force of infection. The analysts interpret empirical estimates for model parameter values in Bayesian terms as previous distributions. The model then must be calibrated: finding posterior distributions of the model parameter values so+ that the model generates accurate estimates of HIV prevalence, the number of people on treatment, and any other epidemiological data that are available (such as HIV-related deaths). The calibration can be performed automatically, manually, or a combination. Model calibration and validation normally should be performed in consultation with governments in the countries in which the model is being applied.

Table A.1 Input parameters of the model

	Biological parameters	**Behavioral parameters**	**Epidemiological/Other parameters**
Population parameters	Background death rate		Population sizes (T, P)
HIV-related parameters	Sexual HIV transmission probabilities* STI-related transmissibility increase* Condom efficacy* Circumcision efficacy* HIV health state progression rates (H) HIV-related death rates (H)	Number of sexual partners* (T, P, S) Number of acts per partner* (S) Condom usage probability* (T, P) Circumcision probability* (T)	HIV prevalence (T, P) STI prevalence (T, P)

Table A.1 Input parameters of the model *(Continued)*

	Biological parameters	Behavioral parameters	Epidemiological/Other parameters
MTCT parameters	Mother-to-child transmission probability*	Birth rate* PMTCT access rate* (T)	
	Injecting HIV transmissibility* Syringe cleaning efficacy* Drug-related death rate	Number of injections* (T) Syringe sharing probability* (T) Syringe cleaning probability* Methadone treatment probability (T)	
Treatment parameters	ART efficacy in reducing infectiousness* ART failure rates	HIV testing rates (T, P, H)	Number of people on ART
Economic parameters	Health utilities		Costs of all prevention, care and treatment programs, enablers and management (T, I) Discounting and inflation rates (T) Health care costs

Source: UNSW study team.
Note: * = Parameter is used to calculate the force of infection; H=Parameter depends on health state; I = Parameter depends on intervention type; P=Parameter depends on population group; S = Parameter depends on sexual partnership type; T = Parameter value changes over time.

HIV Resource Optimization and Program Coverage Targets

A novel component of Optima is its ability to calculate allocations of resources that optimally address one or more HIV-related objectives (for example, impact-level targets in a country's HIV national strategic plan). Because this model also calculates the coverage levels required to achieve these targets, Optima can be used to inform HIV strategic planning and the determination of program coverage levels. The key assumptions of resource optimization are the relationships among (1) the cost of HIV programs for specific target populations, (2) the resulting coverage levels of targeted populations with these HIV programs, and (3) how these coverage levels of HIV programs for targeted populations influence behavioral and clinical outcomes. Such relationships are required to understand how incremental changes in spending (marginal costs) affect HIV epidemics.[18] Logistic functions can incorporate initial start-up costs and enable changes in behavior to saturate at high spending levels, thus better reflecting program reality. The logistic function has the form:

$$L(x) = A + \frac{B - A}{1 + e^{-(x - C)/D}},$$

where L(x) relates spending to coverage; x is the amount of funding for the program; A is the lower asymptote value (adjusted to match the value of L when there is no spending on a program); B is the upper asymptote value (for very high spending); C is the midpoint; and D is the steepness of the transition from A to B. For its fits, the team typically chose saturation values of the coverage to match behavioral data in countries with heavily funded HIV

18 A traditional approach is to apply unit cost values to inform a linear relationship between money spent and coverage attained. This assumption is reasonable for programs such as an established ART program that no longer incurs start-up or initiation costs. However, the assumption is less appropriate for condom promotion and behavior change communication programs. Most HIV programs typically have initial setup costs, followed by a more effective scale-up with increased funding. However, very high coverage levels have saturation effects because these high levels require increased incremental costs due to generating demand and related activities for the most difficult-to-reach groups. Optima uses a logistic function fitted to available input data to model cost–coverage curves (Appendix 2).

responses.[19] To perform the optimization, Optima uses a global parameter search algorithm called Bayesian adaptive locally linear stochastic descent (BALLSD). BALLSD is similar to simulated annealing in that it makes stochastic downhill steps in parameter space from an initial starting point. However, unlike simulated annealing, BALLSD chooses future step sizes and directions based on the outcome of previous steps. For certain classes of optimization problems, the team has shown that BALLSD can determine optimized solutions with fewer function evaluations than traditional optimization methods, including gradient descent and simulated annealing.

While all HIV interventions have some direct or indirect non-HIV benefits, some programs including opiate substitution therapy (OST) or conditional cash transfers, have multiple substantial proven benefits across different sectors. Such additional benefits were reflected by using the approach of a cross-sectoral financing model to effectively distribute the costs in accordance with the benefits. By adapting standard techniques from welfare economics to attribute the benefits of OST programs across the benefiting sectors, it was estimated that average HIV-related benefits are approximately only 10 percent of the overall health and social benefits of OST. Therefore, only 10 percent of the OST cost was included in the optimization analysis.

Uncertainty Analyses

Optima uses a Markov chain Monte Carlo (MCMC) algorithm for performing automatic calibration and for computing uncertainties in the model fit to epidemiological data. With this algorithm, the model is run many times (typically, 1,000–10,000) to generate a range of epidemic projections. Their differences represent uncertainty in the expected epidemiological trajectories. The most important assumptions in the optimization analysis are associated with the cost-coverage and coverage-outcome curves. To incorporate uncertainty in these curves, users define upper and lower limits for both coverage and behavior for no spending and for very high spending.[20]

19 Program coverage for zero spending, or behavioral outcomes for zero coverage of formal programs, is inferred using data from early on in the epidemic or just before significant investment in HIV programs. Practically, the team also discussed the zero and high spending cases with local experts, who could advise on private sector HIV service delivery outside the governments' expenditure tracking systems. For each HIV program, the team derived one set of logistic curves that related funding to program coverage levels and another set of curves (generally, linear relationships) that related coverage levels to clinical or behavioral outcomes (the impacts that HIV strategies aim to achieve).

20 All available historical spending data and achieved outcomes of spending, data from comparable settings, experience, and extensive discussion with stakeholders in the country of application can be used to inform these ranges. All logistic curves within these ranges then are allowable and are incorporated in Optima uncertainty analyses. These cost-coverage and coverage-outcome curves thus are reconciled with the epidemiological, behavioral, and biological data in a Bayesian optimal way, thereby enabling the calculation of unified uncertainty estimates.

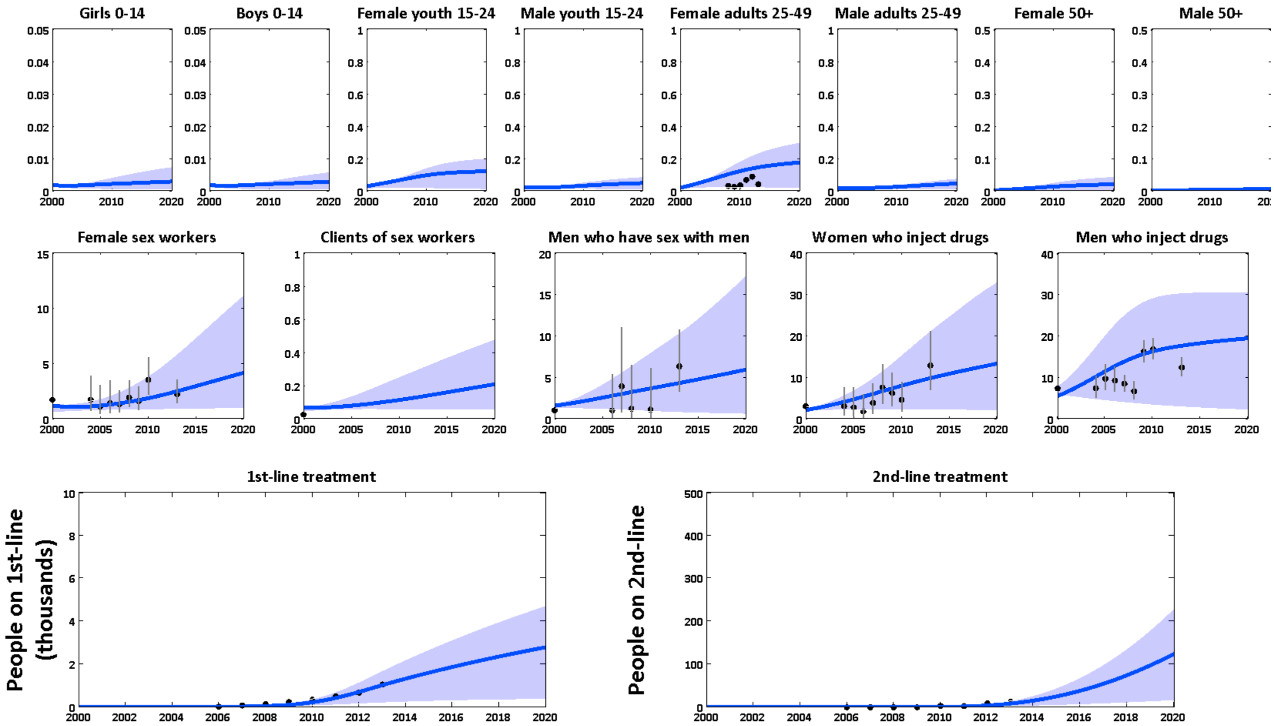
APPENDIX B. MODEL CALIBRATION FIGURES

A key stage in the Optima modelling process is "calibration." Calibration aims to align the Optima-projected trends with the historically observed trends in HIV prevalence in different population groups in a given context. Given the challenges inherent in fitting epidemiological and behavioral data, the calibration for the Kyrgyz Republic was performed manually (by varying relevant model parameters to achieve a best-fit between model-projected and historic HIV prevalence) and in close collaboration with in-country stakeholders.

Black dots represent available data for HIV prevalence. Lines attached to these discs represent uncertainty bounds. The solid curve is the best fitted estimation of HIV prevalence in each subpopulation.

For treatment, black discs represent available data for the number of people on ART. Lines attached to these discs represent uncertainty bounds. The solid curve is the best fitting simulation of total ART patient numbers.

Figure B.1 Calibration of Optima model to the HIV epidemic in *the Kyrgyz Republic, 2000–20*



APPENDIX C. COST-COVERAGE-OUTCOME CURVES

To assess how incremental changes in spending affect HIV epidemics and thus determine the optimized funding allocation, the model parameterizes relationships among the cost of HIV intervention programs, the coverage level attained by these programs, and the resulting outcomes. These relationships are specific to the country, population, and program being considered.

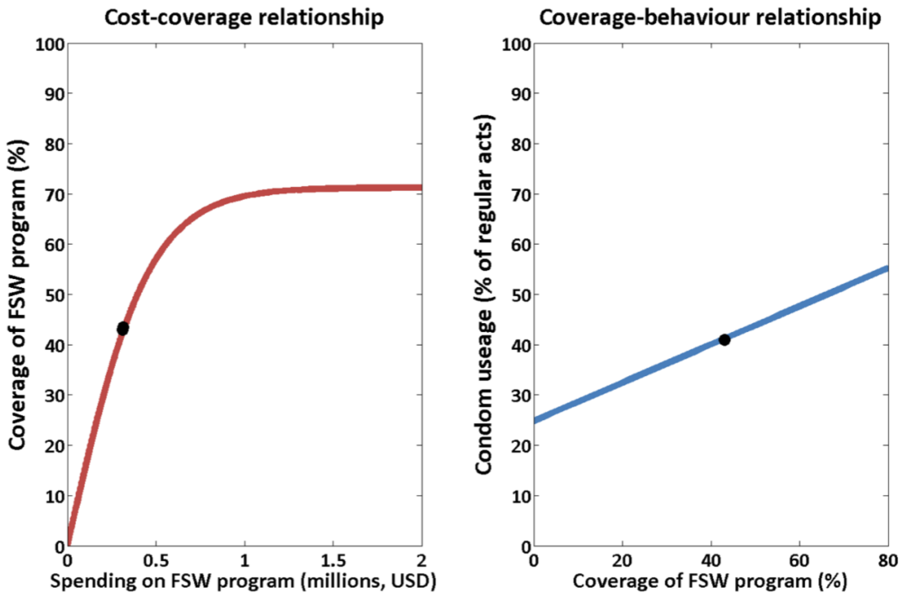
Using the relationships among cost, coverage, and outcome—in combination with Optima's epidemic module—it is possible to calculate how incremental changes in funding allocated to each program, will impact overall epidemic outcomes. Furthermore, by using a mathematical optimization algorithm, Optima is able to determine the optimized allocation of funding across different HIV programs.

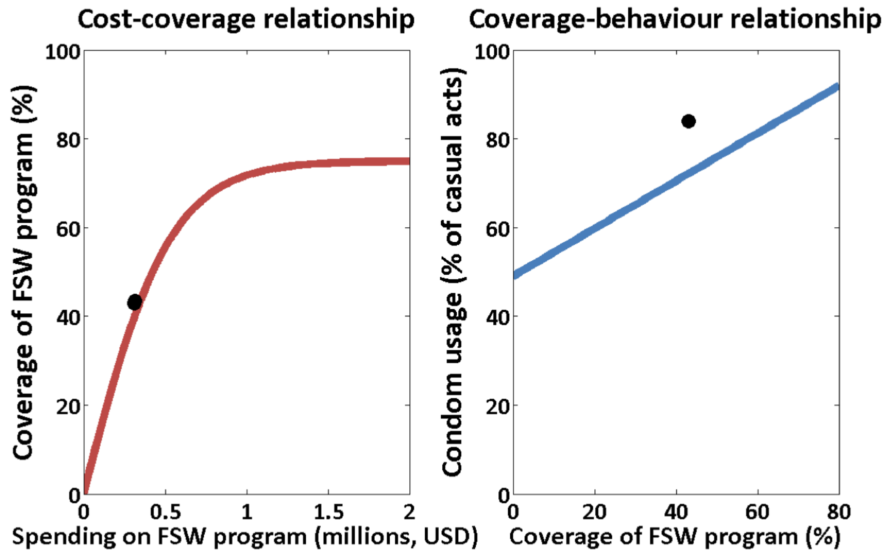
The relationship between program spending and coverage is shown in the left panel of Figure C. 1. This relationship describes the level of output (availability of a service to a specific proportion of the target population) achieved with a specific level of financial input (cost in US$). For example, this relationship describes how many female sex workers could be provided with a standard package of services with an investment of US$0–US$1,000,000. The relationship between coverage levels and outcome is shown in the right panel. This relationship describes the proportion of people who would adopt a specific behavior (such as condom use or needle-sharing). These relationships were produced in collaboration with the Kyrgyz Republic experts.

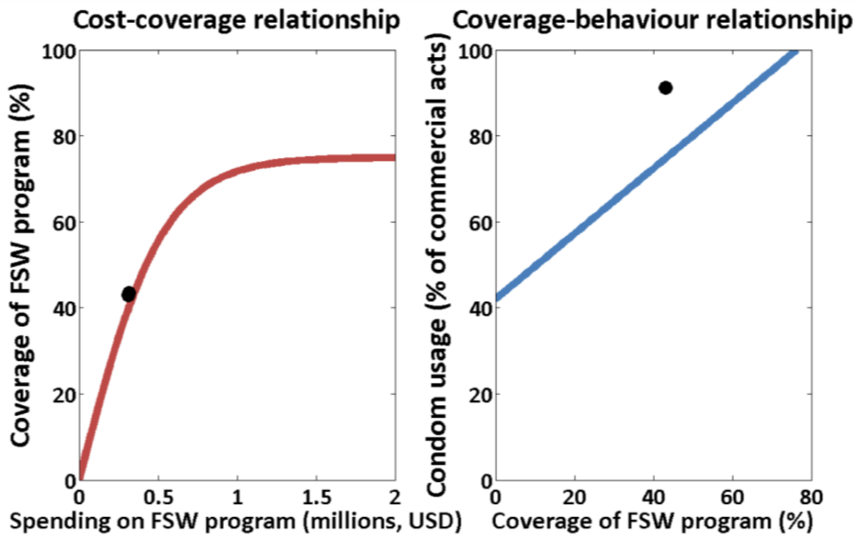
Black discs represent available spending, coverage data, and associated behaviors. The solid curves are the best fitting or assumed relationship.

Figure C.1 Logistic cost-outcome relationships for the Kyrgyz Republic

a. FSW programs: Condom use in regular acts, casual acts, and commercial acts

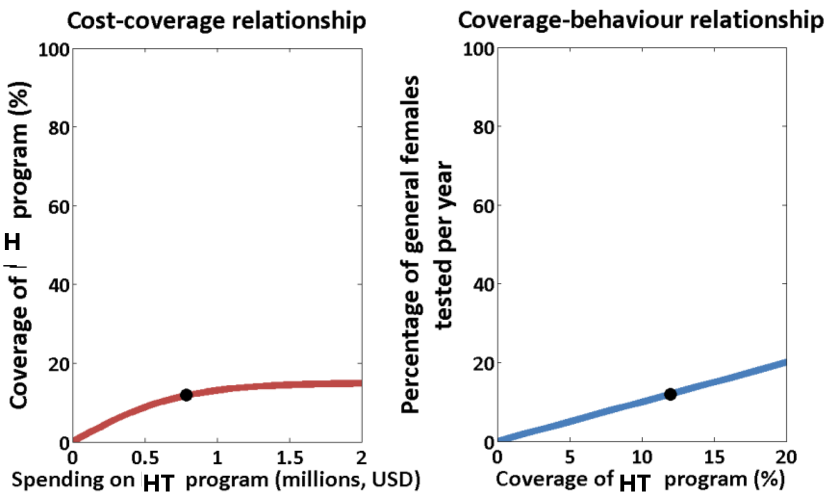


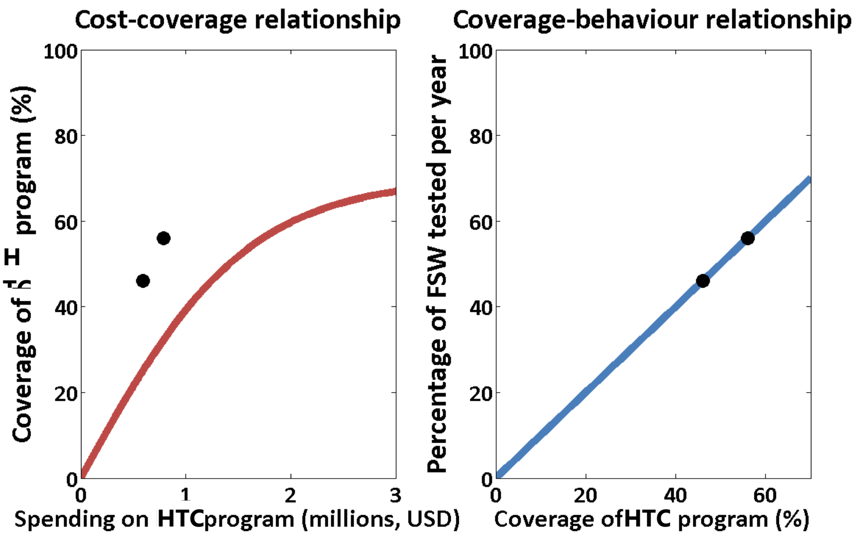


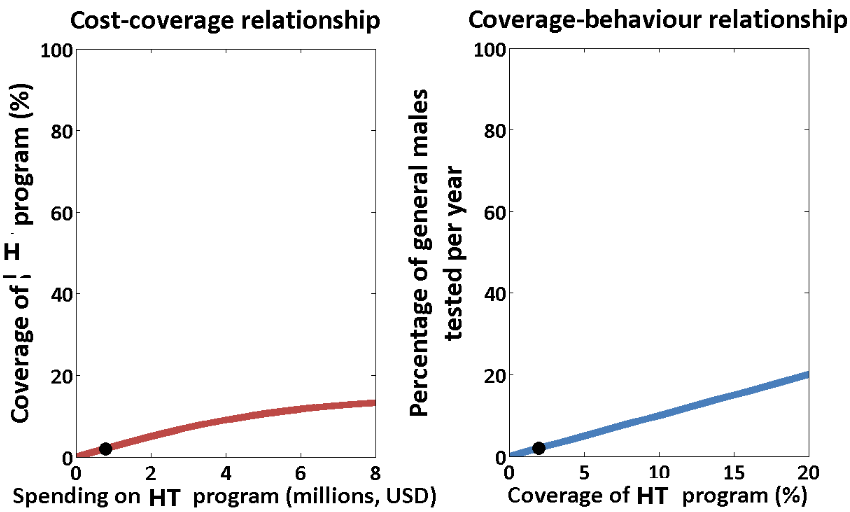


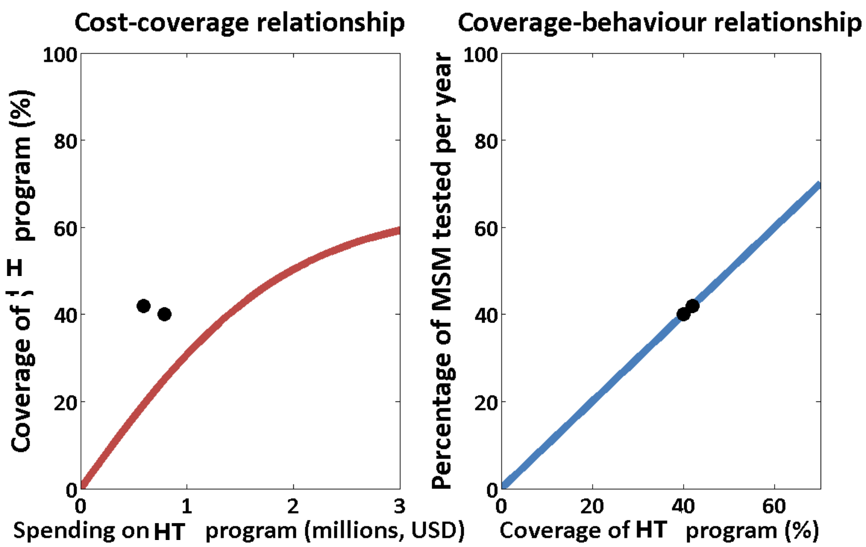
Source: For all figures in this chapter: Populated Optima model based on national cost, coverage, and behavior data provided in the Optima data entry spreadsheet.

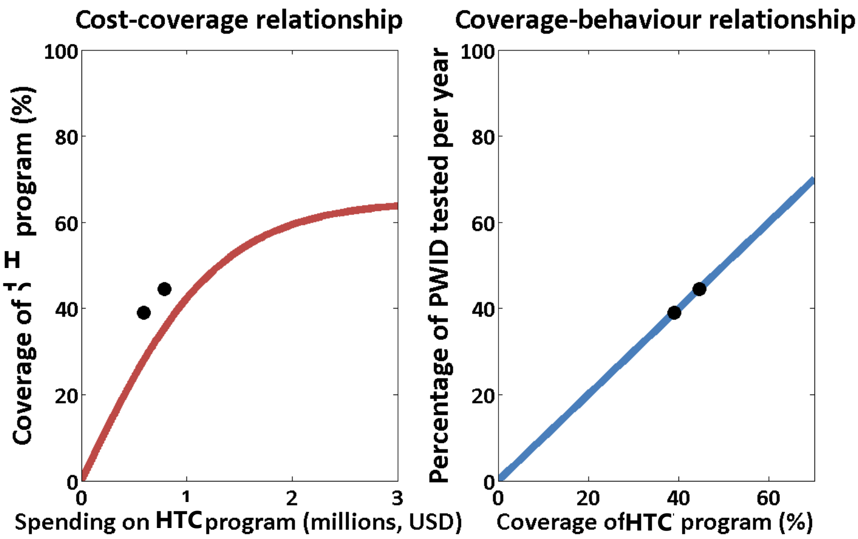
b. HIV testing and counselling for different populations



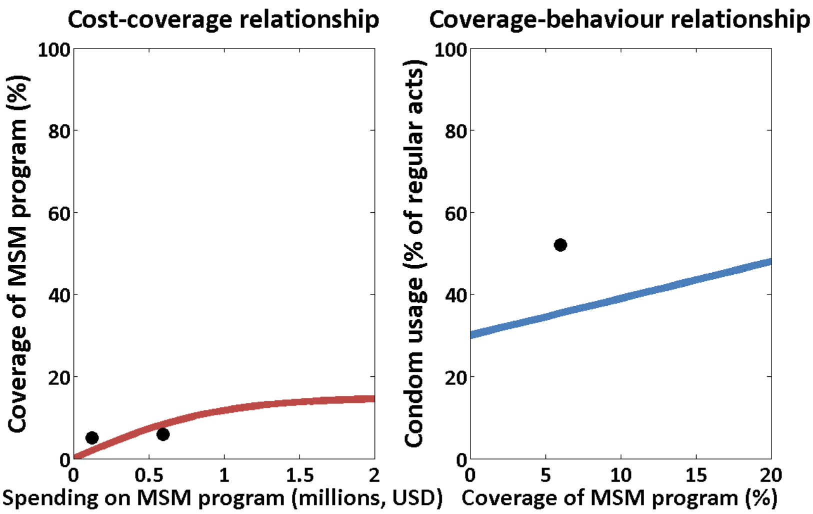

Cost-coverage relationship
Coverage-behaviour relationship
Spending on HTC program (millions, USD)
Percentage of FSW tested per year
Coverage of HTC program (%)

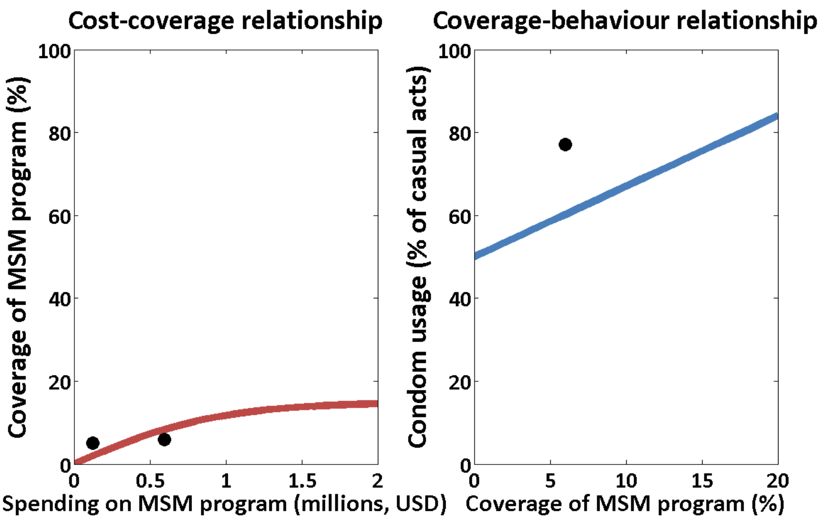

Cost-coverage relationship
Coverage-behaviour relationship
Spending on HT program (millions, USD)
Percentage of general males tested per year
Coverage of HT program (%)


Cost-coverage relationship
Coverage-behaviour relationship
Spending on HT program (millions, USD)
Percentage of MSM tested per year
Coverage of HT program (%)

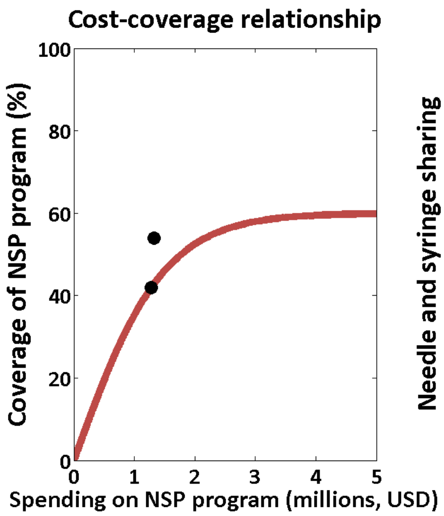


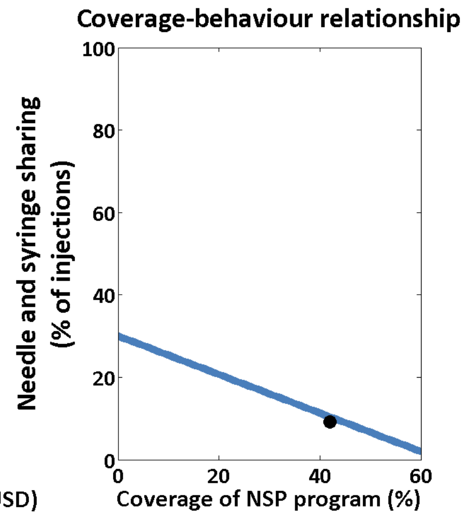
c. MSM programs: Condom use in regular and casual acts



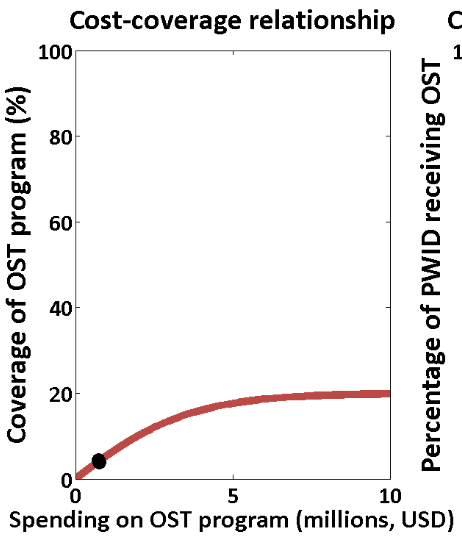


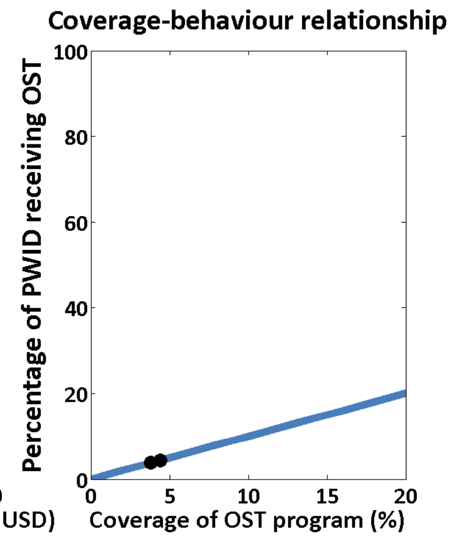
d. Needle and syringe programs for PWID



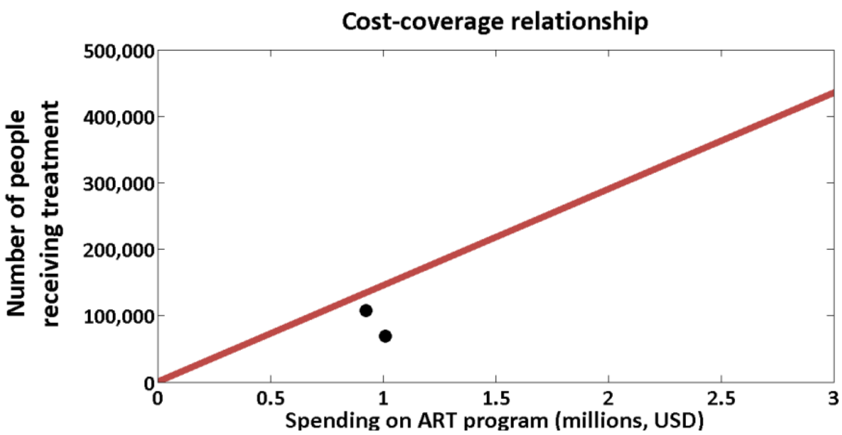


e. Opioid substitution therapy (OST)



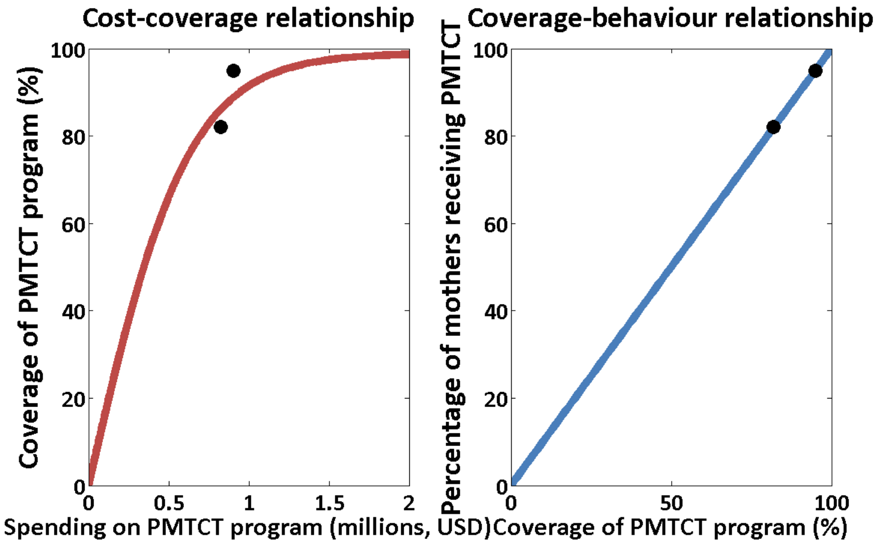


f. Antiretroviral therapy (ART)



Note: Where the relationship represented through the red line does not pass through the data points , as in this case, other evidence suggested that past cost patterns will not represent future cost, for example, because past cost patterns included start-up costs that will not be incurred in future.

g. Prevention of mother-to-child transmission (PMTCT)



APPENDIX D. DETAILED RESEARCH QUESTIONS PRIORITIZED IN THIS ANALYSIS

Analysis 1: How can the Republic of Kyrygyz optimize the allocation of HIV funding, and will optimization meet the stated targets?

This analysis compares the trajectory of the epidemic and key outcomes under the current allocation of resources against an optimized allocation of resources. For this analysis, funding levels are not varied, only the way that funding is spent. The aim is to determine how the Kyrgyz Republic can allocate available resources to achieve maximum impact, and how close that maximum impact will be to the national strategy targets described.

Analysis 1 asks 2 questions:

1. What will be the expected annual levels of HIV incidence, HIV prevalence, and AIDS-related deaths if current funding allocations are maintained? The results of this analysis are described in chapter 3 and explored in chapter 4.
2. If funding is kept at the same level, but resources are allocated in an optimized way, what will be the expected annual levels of HIV incidence, HIV prevalence, and AIDS-related deaths?

The results of this analysis are described in chapter 5.

Analysis 2: What might be gained from increased investment in HIV programs?

This analysis explores what could be achieved with an increase in the available budget. The previous analysis assumed fixed amounts of available funding and explored an optimized allocation of those funds to see how close it is possible to get to the national targets with the current budget. In contrast, Analysis 2 aims for the maximum possible reduction of new deaths and infections. The results are presented in chapter 6.

Analysis 3: What is the minimum spend required to meet the national strategy targets?

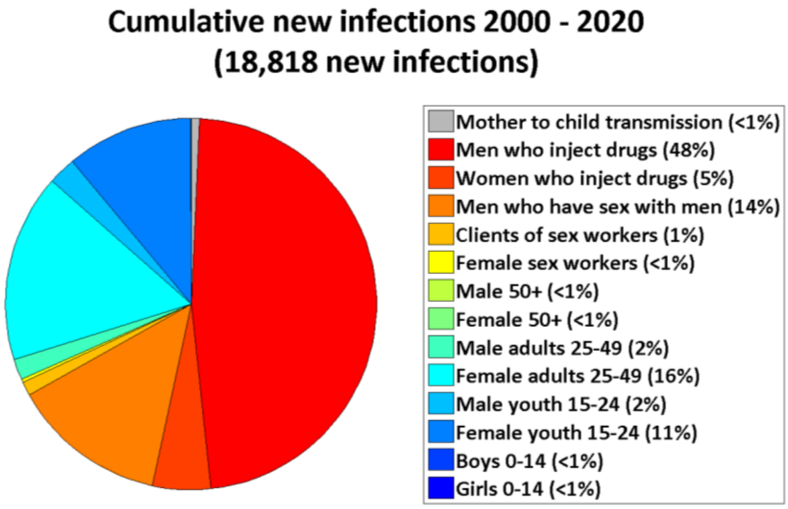
This analysis identifies the minimum resource requirements to achieve the national strategy targets. Analysis 3 also assesses the gap in funding required to achieve these targets. The results are presented in chapter 7.

APPENDIX E. ADDITIONAL RESULTS NOT INCLUDED IN THE BODY OF THE REPORT

Cumulative new HIV infections by population group in the Kyrgyz Republic's HIV epidemic

Figure E.1 shows the total number of new HIV infections by population group between 2000 and 2020.

Figure E.1 Model-predicted cumulative HIV infections by population, 2000–20



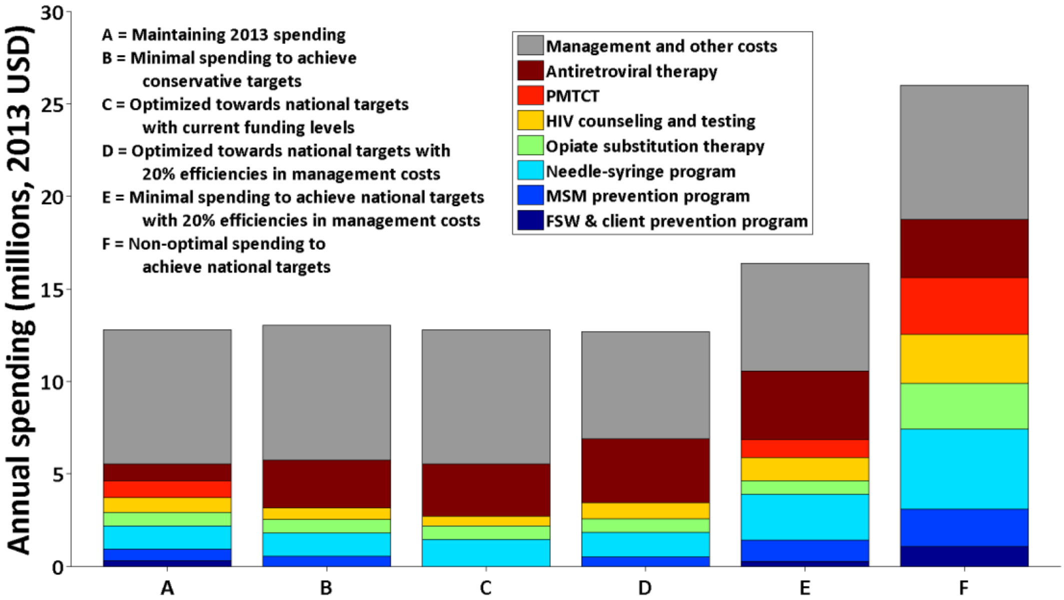
Source: Populated Optima model for the Kyrgyz Republic.

Allocations to achieve national strategy targets

Figure E.2 presents optimized allocations to achieve national targets. Allocation B represents the 2014 level of spending and allocations. Allocation C is the optimized allocation to achieve conservative targets, which were defined as no increase in new HIV infections and deaths. These could be achieved with optimized allocation of $13.3 million per year, similar to the amount available in 2013. For the sake of completeness and comparison, optimized allocations at current level of spending (D and E) are included in Figure E.2.

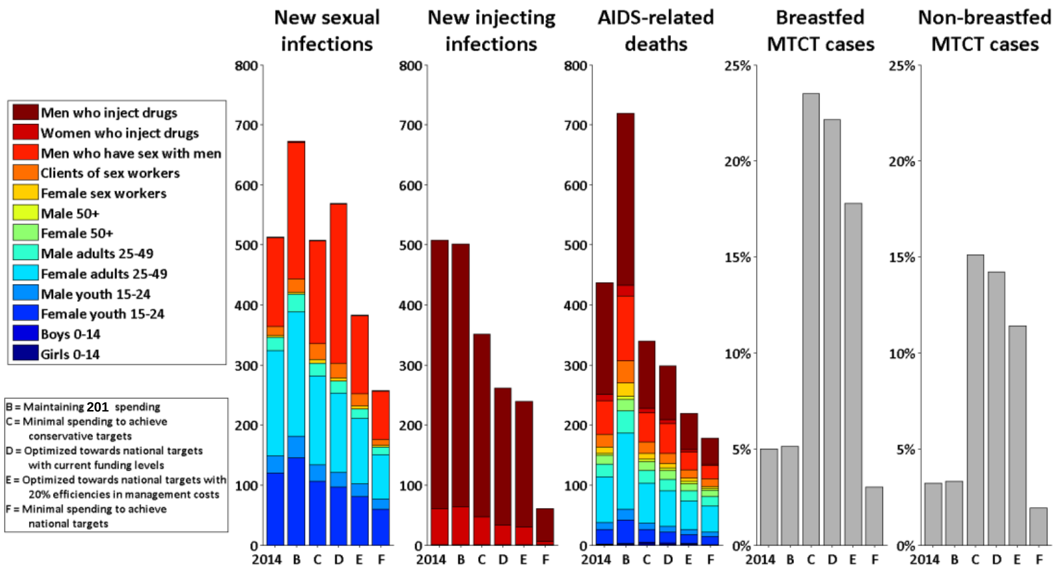
D and E are allocations to get as close as possible to national targets, but they do not *achieve* national targets. Allocation F shows that approximately $24 million would be required to achieve national targets (50 percent reduction of HIV incidence and deaths by 2020), assuming that current unit costs are valid and that management cost would grow proportionately with current allocations. Allocation G shows the amount that would be required to achieve national targets if the distribution of resources across programs remained at its 2014 level of approximately US$43 million. The difference in spending (US$19 million) between Allocations F and G is the estimated amount that could be saved annually by optimizing allocation of spending to achieve national targets. Additional savings on other costs will be explored further in Figure E.3.

Figure E.2 Optimizing spending toward national targets and to achieve national targets by 2020



Source: Populated Optima model of the Kyrgyz Republic.

Figure E.3 Comparison of epidemic outcomes key to the national targets



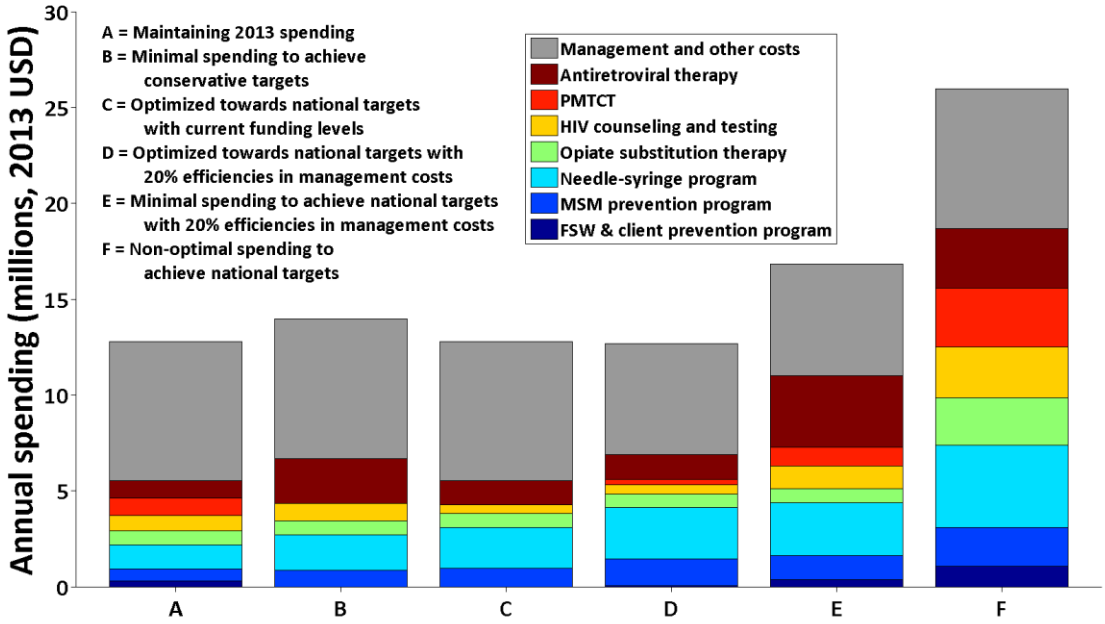
Source: Populated Optima model for ***the Kyrgyz Republic***.

Figure E.3 illustrates the health outcomes on the national targets of implementing the different allocations and should be viewed in association with Figure E.2. The bars presented in Figure E.3 show the projected national health outcomes in 2020 under each of the scenarios represented in Figure E.2. The first bar in each of the subplots shows the estimated 2014 values of the respective health outcome indicator. The bars that represent Allocation C––the minimal amount of money required to achieve conservative targets––illustrate that Allocation C is estimated to lead to no increase in either new infections (sexual or injecting) or deaths from 2014 levels by 2020. Similarly, Allocations D and E show that, by redistributing current resources, decreases in infections and deaths can be achieved by 2020 compared to 2014 levels. These compare favorably to the projection under the Allocation B scenario, which shows the estimated health outcomes if current funding distribution is maintained. Indeed, under the assumption that current funding distributions will be maintained, the number of new infections and AIDS-related deaths is expected to increase from 2014 levels by 2020. The bars that represent Allocation F show that the national targets of 50 percent reductions in incidence and deaths from 2014 levels and the elimination of MTCT are expected to be achieved by 2020.

Optimization results up to 2030

Figures E.4 and E.5 show the optimized allocations for the same targets defined in chapter 7 but for 2015–30. The results are similar to those obtained in the previous chapters However, these results for the longer time frame have a slight emphasis toward prevention programs and away from treatment programs. This shift perhaps is not surprising because preventing an infection in the short term means that resources will not have to be used to treat the individual in the longer term. Interestingly, the estimated minimal amount of annual funding required to achieve the conservative targets by 2030 is slightly larger when compared to the resources required to achieve this goal by 2020. This result highlights that achieving the long-term control of an epidemic may be just as challenging as achieving the short-term control.

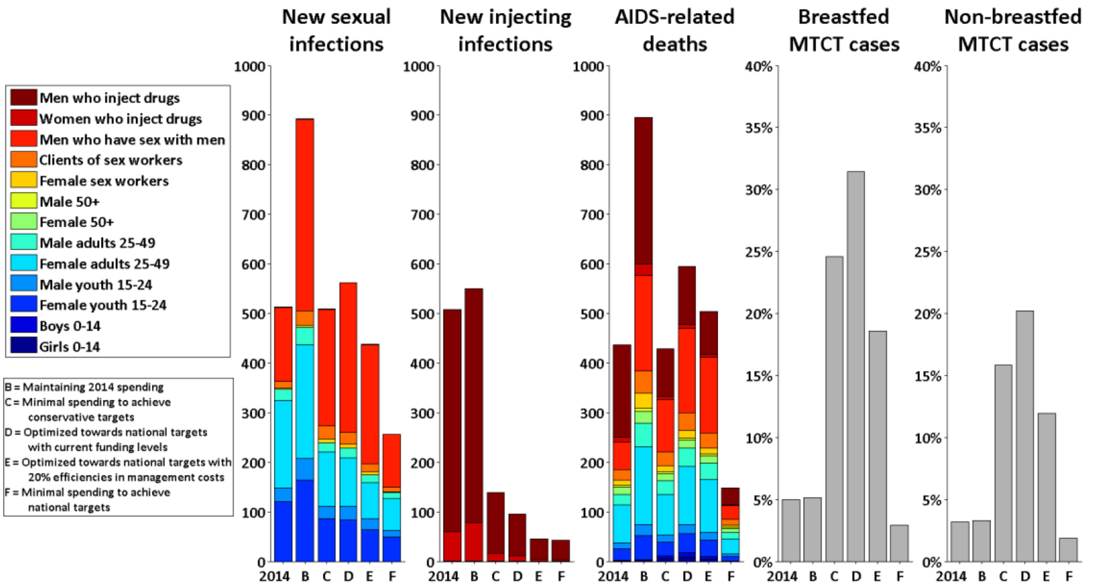
Figure E.4 Optimizing spending toward achieving the same targets as defined in section 2.3 and analyzed in chapter 7 over an extended time period (2015-2030)



Source: Populated Optima model of the Kyrgyz Republic.

Figure E.5 should be viewed in association with Figure E.4. The bars presented in Figure E.5 show the projected national health outcomes in 2030 under each of the scenarios represented in Figure E.4. The first bar in each of the subplots shows the estimated 2014 values of the respective health outcome indicator.

Figure E.5 Comparison of epidemic outcomes key to the national targets in 2030 compared to 2014 levels (first bar in each subplot)



Source: Populated Optima model.

APPENDIX F GLOSSARY

Allocative efficiency (AE)	Within a defined resource envelope, AE of health or HIV-specific interventions provides the right intervention to the right people at the right place in the correct way to maximize targeted health outcomes.
Behavioral intervention	Discourages risky behaviors and reinforces protective ones, typically by addressing knowledge, attitudes, norms, and skills.
Biomedical intervention	Biomedical HIV intervention strategies use medical and public health approaches to block infection, decrease infectiousness, and reduce susceptibility.
Bottom-up costing	Costing method that identifies all of the resources that are used to provide a service and assigns a value to each of them. These values then are summed and linked to a unit of activity to derive a total unit cost.
Cost-effectiveness analysis (CEA)	Form of economic analysis that compares the relative costs and outcomes (effects) of two or more courses of action.
Effectiveness	Degree of achievement of a (health) outcome in a real-world implementation setting.
Efficiency	Achievement of an output with the lowest possible input without compromising quality.
Financial sustainability	Ability of government and its partners to continue spending on a health or HIV outcome for the required duration and to meet any cost of borrowing without compromising the government's, household's, or other funding partner's financial position.
HIV incidence	Estimated total number (or rate) of new (total number of diagnosed and undiagnosed) HIV infections in a given period.
HIV prevalence	Percentage of people who are infected with HIV at a given point in time.
Implementation efficiency	Set of measures to ensure that programs are implemented in a way that achieves outputs with the lowest input of resources. In practical terms, improving implementation efficiency means identifying better delivery solutions. Doing so requires improving planning, designing service delivery models, and assessing and addressing service delivery "roadblocks." Implementation efficiency will improve the scale, coverage, and quality of programs.
Incremental cost-effectiveness ratio (ICER)	Equation commonly used in health economics to provide a practical approach to decision making regarding health interventions. ICER is the ratio of the change in costs to incremental benefits of a therapeutic intervention or treatment.
Model	Computer system designed to demonstrate the probable effect of two or more variables that might be brought to bear on an outcome. Such models can reduce the effort required to manipulate these factors and present the results in an accessible format.
Opioid substitution therapy (OST)	Medical procedure of replacing an illegal opioid, such as heroin, with a longer acting but less euphoric opioid. Methadone or buprenorphine typically are used, and the drug is taken under medical supervision.

Opportunistic infection under medical (OI prophylaxis)	Treatment given to PLHIV to prevent either a first episode of an OI (primary prophylaxis) or the recurrence of infection (secondary prophylaxis).
Pre-exposure prophylaxis (PrEP)	Method for people who do not have HIV but are at substantial risk of acquiring it to prevent HIV infection by taking an antiretroviral drug.
Program effectiveness	Program effectiveness incorporates evaluations to establish what works and impacts disease and/or transmission intensity, disseminating proven practice, and improving the public health results of programs.
Program sustainability	Ability to maintain the institutions, management, human resources, service delivery, and demand generation components of a national response until impact goals have been achieved and maintained over time as intended by the strategy.
Return on investments (ROI)	Performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. To calculate ROI, the benefit (return) of an investment is divided by the cost of the investment; the result is expressed as a percentage or a ratio.
Saturation	Maximum level of coverage that a program can achieve.
Technical efficiency	Delivery of a (health) service in a way that produces maximum output at the lowest possible unit cost while according with operational quality standards.
Top-down costing	Costing method that divides total expenditure (quantum of funding available) for a given area or policy by total units of activity (such as patients served) to derive a unit cost.
Universal health coverage (UC)	Universal health coverage (UC), is defined as ensuring that all people have access to the promotive, preventive, curative, rehabilitative, and palliative health services that they need, of sufficient quality to be effective, while ensuring that the use of these services does not expose the user to financial hardship.

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