Optimizing Investments in Moldova's HIV Response

Ministerul Sănătății
al Republicii Moldova

Bundesministerium
für Gesundheit

The Global Fund

UNSW
AUSTRALIA

UNAIDS

UNDP
Empowered lives.
Resilient nations.

WORLD BANK GROUP

OPTIMIZING INVESTMENTS IN MOLDOVA'S HIV RESPONSE

Ministerul Sănătății al Republicii Moldova

Bundesministerium für Gesundheit

The Global Fund

UNSW AUSTRALIA

UNAIDS

UNDP Empowered lives. Resilient nations.

WORLD BANK GROUP

CONTENTS

Appendixes

Figures

Tables

ACKNOWLEDGMENTS

The HIV allocative efficiency 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, the United Nations Program on HIV/AIDS (UNAIDS), and the United Nations Development Programme (UNDP). The Steering Committee of the program—comprising Christoph Hamelmann (UNDP), Manoela Manova (UNAIDS), Emiko Masaki (World Bank), Shufang Zhang (The Global Fund), and Feng Zhao (Chair and World Bank Task Team Leader)—provided overall guidance to the country studies. The four agencies and the German Federal Ministry of Health also cosponsored the various study activities.

The core analysis and report-writing team included Tatiana Alexeenco (Coordinator of HIV regional program, Eastern region), Liliana Caraulan (Center of Health Policies and Studies), Tatiana Costin, Valeriu Plesca (both National Center of Health Management), Lilia Gantea (Ministry of Health), Stefan Gheorghita (National Center of Public Health), Lucia Pirtina, Svetlana Popovici (both Hospital of Dermatology and Communicable Diseases), Svetlana Plamadeala (UNAIDS), Richard Gray (UNSW); and Clemens Benedikt, Alona Goroshko, Emiko Masaki, and Michael Obst (all World Bank). Substantial technical inputs also were provided by David Kokiashvili, Tsovinar Sakanyan, Tatiana Vinichenko, and Shufang Zhang (The Global Fund); Roman Hailevich and Manoela Manova, (UNAIDS); Predrag Đurić and Christoph Hamelmann (UNDP); Cliff Kerr, Robyn M. Stuart, and David P. Wilson (all UNSW); Son Nam Nguyen (previous World Bank Task Team Leader); and Marelize Görgens and David Wilson (World Bank). The study report also greatly benefitted from the review by Ulrich Laukamm-Josten (Consultant). Alicia Hetzner edited this report.

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

The authors also thank all other stakeholders and colleagues who provided insights and support.

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
CEA	cost-effectiveness analysis
CD4 cell	T–lymphocyte cell bearing CD4 receptor
CIS	Commonwealth of Independent States
CRS	creditor reporting system (OECD)
CSW	clients of female sex workers
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, The	Global Fund to Fight AIDS, Tuberculosis and Malaria
GoM	Government of Moldova
HIV	human immunodeficiency virus
HTC	HIV testing and counseling
IBBS	integrated bio-behavioral surveillance
ICER	incremental cost-effectiveness ratio
IDU	injection drug use
IMF	International Monetary Fund
INSERM	Institut national de la santé et de la recherche médicale
KP	key population
LB	left bank of the Nistru River
MARP	most at-risk population
MCMC	Markov Chain Monte Carlo
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
OECD	Organisation for Economic Co-operation and Development
OST	opiate substitution therapy
PLHIV	people living with HIV
PMTCT	prevention of mother-to-child transmission
PWID	people who inject drugs
RB	right bank of the Nistru River
ROI	return on investment
SDG	Sustainable Development Goal
STI	sexually transmitted infections
THE	total health expenditure
UC	universal health coverage

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

The rest of this page is intentionally left blank.

KEY MESSAGES

Moldova continues to experience a concentrated HIV epidemic among people who inject drugs (PWID), men who have sex with men (MSM), female sex workers (FSW), and their clients and their sexual partners in the general population. The HIV epidemic is more severe on the left bank of the Nistru River, where coverage of prevention programs is lower.

The country could increase the impact of its HIV response by increasing investment from US$8.7 million to US$14.2 million. Compared to continuing current spending, optimally allocating resources will result in a 36 percent decrease in incidence and a 48 percent decrease in HIV-related deaths. Optimal allocation would avert an estimated 4,000 new infections and 2,400 deaths. In the long term, these effects will have not only health benefits but also financial benefits in reduced health care cost for people living with HIV (PLHIV). Optimized allocation of resources would entail:

- Scaling up antiretroviral therapy (ART) and prevention for key populations including in the highly affected areas of east of the Nistru River
- Increasing investment in prevention programs for PWID, opiate substitution therapy (OST) and programs for FSW and MSM
- Improving geographic prioritization and introducing OST, MSM, and FSW programs on the left bank
- Reinvesting funds currently allocated to programs for the general population in the above-mentioned priority programs
- Reviewing the unit cost and technical efficiency of ART and OST programs as well as for management and other costs.

Compared to current levels of program coverage, adding a test and offer treatment approach[1] will enable reducing HIV incidence by 36 percent by 2020. However, in a long-term analysis up to 2030, scaling up an optimized combination of programs would avert 56 percent more new infections and 17 percent more deaths as than scaling up exclusively testing and treatment.

Although HIV accounts for approximately 3.0 percent of disease burden in years of life lost in Moldova, total annual spending on HIV accounted for only 0.8 percent of total health expenditure in 2013. Thirty-three percent of funds for HIV programs was provided by international partners, suggesting the need for a substantial increase in domestic financing of the HIV response.

[1] Defined here as 70% of PLHIV diagnosed and 90% of diagnosed PLHIV on ART by 2020.

The rest of this page is intentionally left blank.

EXECUTIVE SUMMARY

As part of a Regional initiative, the Republic of Moldova conducted an HIV allocative efficiency (AE) analysis to inform its strategic decisions on investment in the HIV response.

Moldova continues to experience a concentrated HIV epidemic, in which the largest portion of new infections occur among key populations. These are people who inject drugs (PWID); men who have sex with men (MSM); and female sex workers (FSW), their clients, and their sexual partners. The epidemic already has transitioned from an early concentrated epidemic in which the highest rates of transmission were among PWID; to an advanced concentrated epidemic in which onward transmission to sexual partners of PWID; sexual transmission among MSM; and among FSW, their clients, and their sexual partners have become large sources of new infections. Assuming that current conditions (program coverage and behaviors) are maintained, the model predicts an **increase in annual new infections over 2015–20 from 1,400 in 2014 to 1,700 in 2020; and to 2,500 in 2030.**

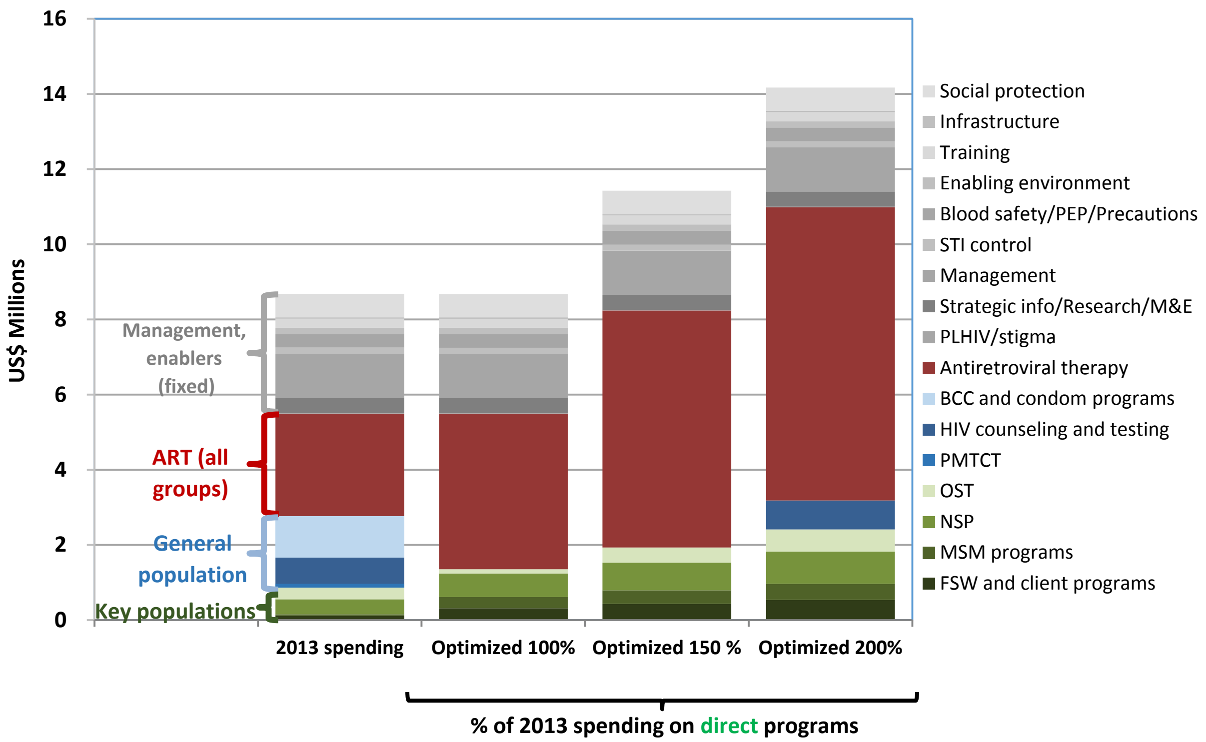
Within Moldova, there is a large variation in the HIV epidemic between the areas west of the Nistru River ("right bank") and the areas east of the Nistru River ("left bank"). On the **right bank,** the fastest growing segment of the HIV epidemic is among MSM, for whom a 3-fold increase in annual new infections is projected by 2030 with prevalence projected to exceed 10 percent by 2020. On the **left bank,** despite projected increases in HIV incidence among MSM and moderate increases among FSW, the largest share of new infections will continue to occur among PWID. **New infections among other female adults** accounts for nearly one-third of new infections, due largely to sexual transmission from male PWID, FSW clients, and MSM.

Available evidence suggests that in the **left bank**, the **HIV epidemic is more severe**. In 2013 in the left bank, 47 new HIV diagnoses were made per 100,000 people vs. 13 per 100,000 on the right bank. Moldova's HIV disease burden is among the highest in Europe, accounting for 9.4 percent of years of life lost (YLL) in the 15–49 age group (University of Washington 2014). The fact that the rates of new diagnoses in the left bank have increased 300 percent since 2004 suggests that **the left bank region is experiencing one of the most severe HIV epidemics in Europe and that the necessity to match this situation with an accelerated HIV response and increased investment is urgent.**

Several optimization analyses were conducted for different levels of funding covering 2015–20 and for achieving the national targets over the same timeframe. Overall trends of allocations in all optimization analyses were similar. They strongly emphasized the **need to increase ART coverage and to focus on prevention among key populations**. **Reallocating funding from programs for the general population to scaling up programs for key populations** is a more efficient use of the available resources.

With increased availability of funding, a large part of the budget should be allocated to ART (Figure 1). If the total HIV budget could be increased by 60 percent,[2] treatment should receive 71 percent of all spending on direct programs, increasing coverage from 23 percent of all PLHIV to 65 percent of all PLHIV. Twenty-two percent of program spending should be allocated to prevention programs. These include needle and syringe programs (NSP) opiate substitution therapy (OST) and programs for MSM as well as FSW (both including condoms), HIV testing and counseling (HTC, and outreach services). To reach this level of ART coverage, another 5 percent of program funding would be allocated to HTC programs for other populations beyond the key populations. This additional HTC still should be well targeted to geographic areas and communities with high HIV prevalence. Pregnant women should continue to be covered with HTC and ART in an integrated way to minimize separate overhead costs for PMTCT. Compared to continuing current spending, the increase of resources to approximately US$14 million, combined with the proposed optimized allocations, would result in a 36 percent decrease in incidence and a 48 percent decrease in HIV-related deaths. The increase also would avert an estimated 4,000 new infections and 2,400 deaths from 2015 to 2020 (Figure 2).

Figure 1.1. Moldova: Current and optimized allocations with 100%, 150%, and 200% of spending on direct programs to minimize HIV incidence and deaths, 2015–20



Source: Populated Optima model for Moldova.

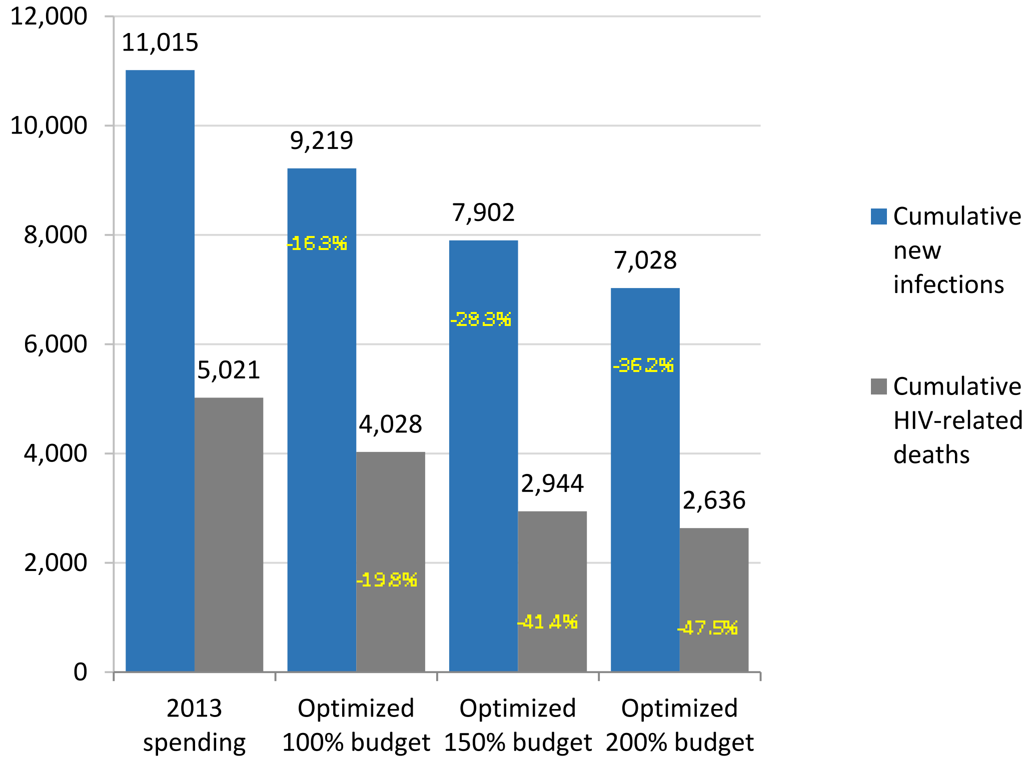
Note: BCC=behavior change communication; FSW=female sex worker; MSM=men who have sex with men; NSP=needle and syringe exchange program; OST=opiate substitution therapy; PLHIV=people living with HIV; PMTCT=prevention of mother-to-child transmission; STI=sexually transmitted infections.

Although the left bank region experiences a more severe HIV epidemic, the only program in place for key populations in 2013 was an NSP program**.** Regardless of the level of funding available, the analyses indicate that **prevention funding for key populations in the left bank region should be increased with a focus on PWID programs** including needle-and syringe exchange and OST but also covering services for MSM and FSW.

---

[2] Equivalent to a 200% increase in spending on direct programs, defined as the programs that directly impact new infections or deaths, and that were part of the mathematical optimization analysis (Figure 1.1. Management, enablers, and other costs were not part of the mathematical optimization so are shaded in gray in Figure 1.

Figure 1.2. Epidemiological impact in Moldova within different funding scenarios: Cumulative incidence and cumulative HIV-related deaths, 2015–20



Source: Populated Optima model for Moldova.

To inform optimized allocations of HIV resources in Moldova, it also will be important to understand the cost structure of Moldova's HIV response. This study did not include a detailed technical efficiency analysis. However, available cost information suggests that prevention programs for key populations in Moldova have relatively low unit costs, whereas, based on a rapid comparison of seven countries, ART and OST costs in Moldova were slightly above average. Consequently, Moldova's ART allocations absorb a relatively large proportion of the country's HIV spending. Optima also suggests that, if funding is limited, the efficiently implemented needle-syringe exchange program would be the most cost-effective option to contain and reverse the epidemic among PWID. **A lower unit cost of ART and OST would create substantial savings, which could then be used to also increase coverage of OST and other programs. Given the already constrained HIV response budget, additional funding for OST could be sought from other health and social programs,** as justified by the wide benefits of OST for health, social integration, and crime reduction.

Introducing new ART guidelines that lead to 70 percent of PLHIV being diagnosed and 90 percent of the diagnosed population being retained on ART will help to slow the spread of HIV and decrease mortality. However, the projections suggest that an **exclusive focus on ART scale-up is less effective and more expensive in the long term** than a scenario of a **combined scale-up of ART and prevention** for key populations (Figure 1, right column).

In summary, Moldova's HIV response is already covering key services required to progress toward reducing the HIV epidemic. Nevertheless, increased investment in HIV, more strategic allocations to key populations, improved geographic targeting, and technical efficiencies are required to achieve the necessary scale-up of programs and corresponding impacts.

The rest of this page is intentionally left blank.

1. INTRODUCTION

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 people living with HIV on treatment, and end HIV-related discrimination by 2015 (UNGASS 2011). The 2014 Gap Report illustrated that, to achieve these targets, substantial additional efforts will be required in most countries (UNAIDS 2014c). Despite the progress made, HIV remained among the unfinished agenda items in the Millennium Development Goals (MDGs), which need to be transitioned and integrated in the post-2015 Sustainable Development Goals (SDGs). 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. Fast Track recommends that resources be concentrated on the programs that have demonstrated the greatest impact.

In this context, a shift toward investment thinking in the design of HIV responses is being promoted by UNAIDS and cosponsors globally to maximize the impact of program investment and best realize the long-term health and economic benefits of HIV programs. Investment cases are being developed by a number of countries to understand HIV epidemics as well as to design, deliver, and sustain effective HIV responses. The investment cases are complemented with a human-rights-based approach to health care. In support of HIV investment cases, in 2014–15, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Ukraine, as well as a number of countries outside the ECA Region, carried out allocative efficiency (AE) analyses.[3] This report summarizes the results of the analysis for policy makers, program leaders, and technical experts in Moldova.

The concept of allocative efficiency (AE) refers to maximizing health outcomes with the least costly mix of health interventions.[4] HIV AE 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?" This concept not only is critical for maximizing current and

3 For published study reports, see, for example, Republic of Tajikistan 2014 and Fraser and others 2014.

4 Technically, maximization can be achieved in two ways: within a fixed budget envelope (maximize impact with given amount of money), or within defined impact targets (minimize cost to achieve a given impact).

future impact. The concept also is an integral element of transition to full domestic financing and sustainability of the response because a response that is allocatively and technically efficient will be easier to sustain.

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.

1.2 Objectives of the analysis

Moldova has set the priorities for its HIV response in its National Strategic Plan 2011–15. The plan includes the following key impact targets:

- Prevalence of HIV among key populations:
  - Among PWID, not higher than 20.0%
  - Among female sex workers, not higher than 11.0%
  - Among MSM, not higher than 5.0%
  - Among prisoners, not higher than 3.5%
  - Among the general population, not higher than 0.44%
- Percentage of adults and children with HIV still alive and known to be on treatment after initiation of antiretroviral therapy:
  - After 12 months, not lower than 88%
  - After 24 months, not lower than 80%
  - After 60 months, not lower than 75%
  - Among infants born to HIV-infected mothers, not higher than 2%
- Prevalence of hepatitis B:
  - Among IDU, not higher than 5.9%
  - Among CSW, not higher than 4.5%
  - Among MSM, not higher than 3.8%
  - Among prisoners, not higher than 11.3%
- Prevalence of hepatitis C
  - Among IDU, not higher than 63.0%
  - Among CSW, not higher than 11.0%
  - Among MSM, not higher than 3.0%
  - Among prisoners, not higher than 10.7%
- Prevalence of syphilis
  - Among IDU, not higher than 2.0%
  - Among CSW, not higher than 3.9%
  - Among MSM, not higher than 7.7%
  - Among prisoners, not higher than 8.5%

The modeling analysis presented in this report was focused on the HIV-related targets because tools for optimization analysis for multiple diseases are still under development. The findings of this study will assist the Government of Moldova to further strengthen its HIV investment case, through which it attempts to increase effectiveness of HIV investments and define corresponding priorities, strategies, and impacts of the response. The national HIV allocative efficiency study was designed to answer four main questions:

1. **How can Moldova 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 that would be required to meet national targets and how should funds be allocated to achieve the targets?**
4. **What are the health and financial impacts of implementing different ART guidelines?**

The rest of this page is intentionally left blank.

2. MOLDOVA'S HEALTH AND HIV FINANCING CONTEXT

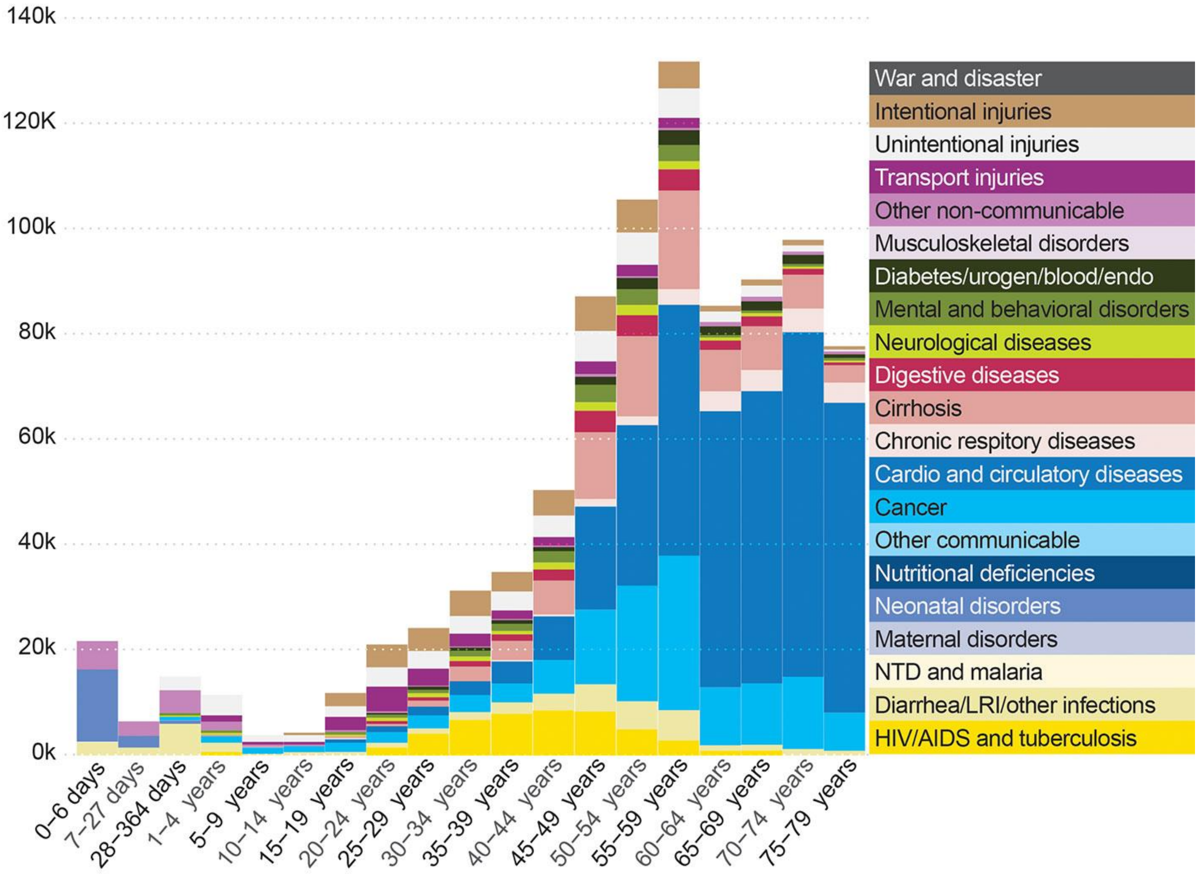
Moldova's third national report on the Millennium Development Goals (MDGs) showed that Moldova had made substantial progress on several objectives before the target date of 2015 (GoM 2013). For example, for MDG1, **poverty incidence decreased** from 34.5 percent in 2006 to 20.8 percent in 2012. The final targets set for 2015 for MDG 4 on infant mortality and under-5 mortality rates also were achieved. In the words of Moldova's third MDG report, the "…most troubling area is MDG6 on combating HIV/AIDS, tuberculosis and other diseases. None of the targets under this goal was achieved, and it will not be possible to reach them by 2015."

2.1 Burden of disease

The general burden of disease in Moldova is characterized by prevailing noncommunicable diseases. In the population aged 45 and above, cardiovascular disease, cancer, and cirrhosis are predominant causes of total years of life lost (YLL) (Figure 2.1). In the working age population, the main causes of YLL are noncommunicable diseases, injuries, as well as HIV/AIDS and tuberculosis. In the age group 15–49, HIV is the second largest cause of YLL accounting for 9.4 percent of all YLL, exceeded only by cirrhosis of the liver. In the age group 40–44, approximately 17 percent of total YLL result from HIV/AIDS and tuberculosis, or 8,539 YLL of a total of 50,000 YYL for this age group. The largest effect on total YLL caused by HIV/AIDS and tuberculosis is observed for the population aged 20–44.

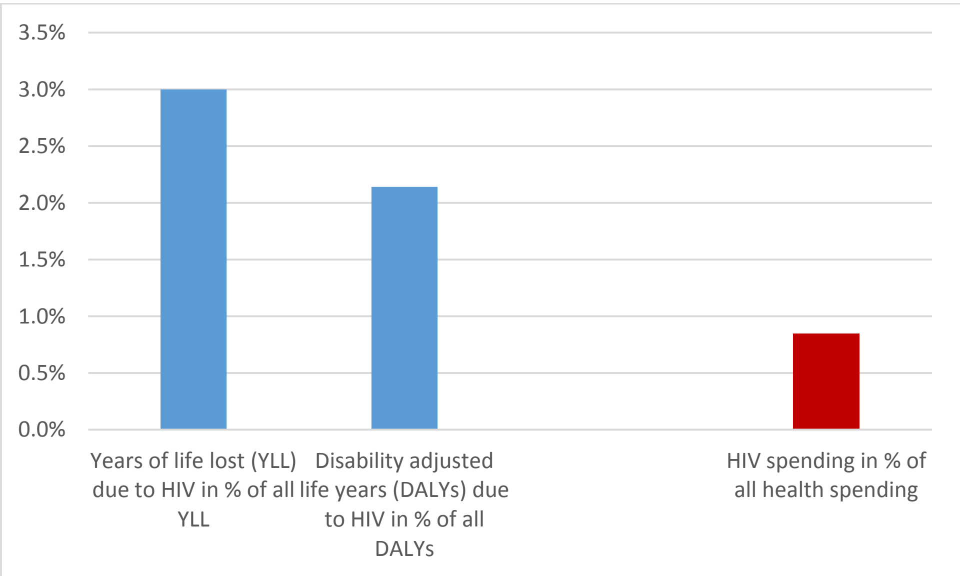
HIV disease burden in Moldova is among the highest in Europe and the second highest after Ukraine among the seven countries included in this Regional initiative. Separate burden of disease estimates for right bank and left bank regions were not available. Nevertheless, data on new HIV diagnoses suggest that the disease burden is approximately three times higher in the left bank region, indicating that the left bank experiences one of the most severe HIV epidemics in Europe. In Moldova, Figure 2.2 illustrates that HIV accounts for 3 percent of YLL and 2.1 percent of disability-adjusted life years (DALYs) overall, but for only 0.8 percent of total health expenditure (THE). In most of the other countries included in the Regional analysis, the level of HIV disease burden and the percentage of health spending allocated to HIV were similar to each other. This finding suggests that **total HIV spending in Moldova has been relatively low compared to disease burden and—considering the large disease burden—low compared to most other countries included in this analysis.**

Figure 2.1 Moldova: Years of life lost (YLL) due to different causes by age, 2010



Source: University of Washington 2014.

Figure 2.2 Moldova: Levels of HIV disease burden compared to levels of HIV spending (%)



Source: WHO Global Health Expenditure Database, http://apps.who.int/nha/database; UNAIDS 2014a, University of Washington 2014.

In the given situation, addressing the continued spread of HIV and HIV/TB co-infection represents an important priority in the effort to increase overall life expectancy as well as to decrease excess mortality by providing comprehensive and efficient services for key populations and PLHIV.

2.2 Health and HIV financing

Moldova is a **lower-middle income economy** that had a total 2013 per capita health expenditure of US$263.[5] According to the latest WHO estimates, public expenditures on health in the Republic of Moldova in 2012 constituted 5.3 percent of GDP, which is lower than the EU average of 7.3 percent. However, in 2012 the share of health spending in the total government expenditure (13.3 percent) was the highest in the Commonwealth of Independent States (CIS) region (average 10.2 percent).

Since January 2004, health financing in Moldova has been based on national **compulsory health insurance**. Total public health spending covers all health care institutions. Interventions at the central and local levels are funded through the national insurance scheme and comprise 90 percent of the public health budget. The Ministry of Health administers approximately 10 percent of health spending, allocated to public health services, several national programs, and central administration. Table 2.1 provides a summary of trends in health expenditure. Overall expenditure for health was growing over the last decade, with increases in all three key sources of funding.

Table 2.1 Moldova: Breakdown of health spending by source of funding, 2000–13

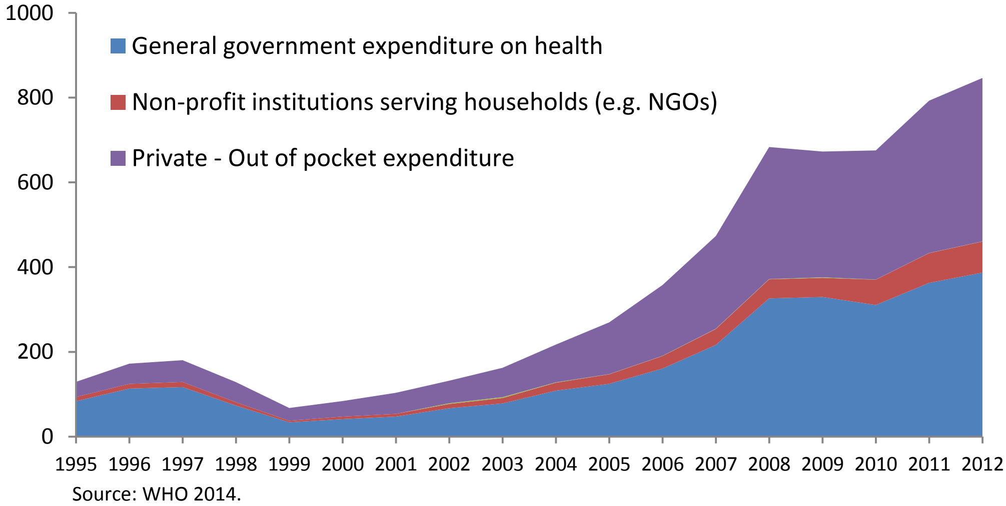
Indicator	Unit	2000	2005	2010	2011	2012	2013
Total health spending							
Gross domestic product	In million current US$	1,285	2,983	5,806	7,031	7,274	7,940
Total expenditure on health	In million current US$	85	273	678	798	857	937
Total health expenditure (THE) % GDP	%	7	9	12	11	12	12
Total expenditure on health/capita at exchange rate	Per capita	23	76	190	224	241	263
Government health spending							
General government expenditure	In million current US$	467	1,105	2,369	2,742	2,916	3,216
General government expenditure on health (GGHE)	In million current US$	41	125	310	364	391	431
GGHE as % of general government expenditure	%	9	11	13	13	13	13
GGHE as % of THE	%	49	46	46	46	46	46
Private health spending							
Private expenditure on health	In million current US$	44	148	367	435	466	506
Private expenditure on health as % of THE	%	51	54	54	54	54	54
Out-of-pocket expenditure as % of THE	%	43	45	45	45	45	45
Out-of-pocket expenditure as % private health expenditure	%	83	82	83	83	83	83
External funding							
Rest of the world funds/External resources	In million current US$	13	12	65	77	63	45
External resources on health as % of THE	%	15	5	10	10	7	5

Source: WHO Global Health Expenditure Database: http://apps.who.int/nha/database.

5 http://data.worldbank.org/indicator/SH.XPD.PCAP.

Out-of-pocket expenditures represent a considerable share of total health spending in the country—almost equal to what the government provides, whereas NGOs' contribution accounts for approximately 10 percent (Figure 2.3).

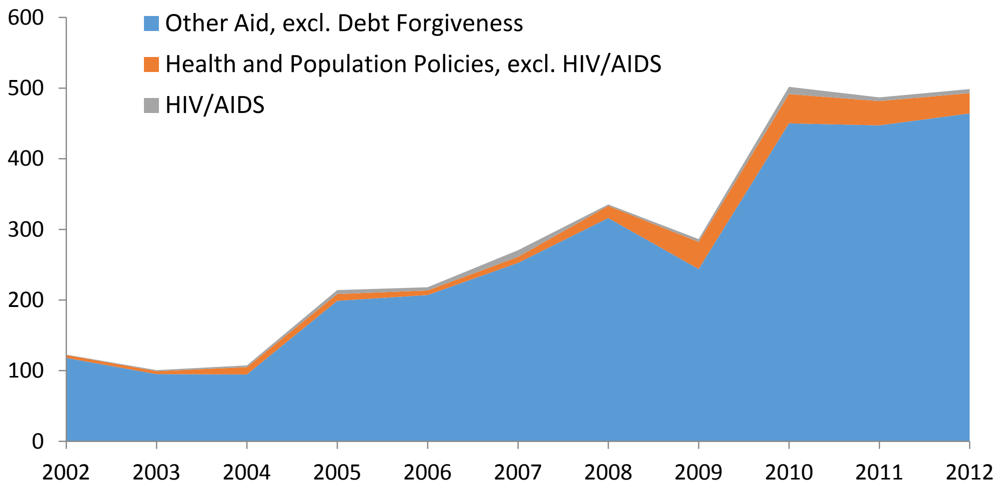
Figure 2.3 Health spending by source of financing, 1995–2012 (US$ million)



Source: WHO 2014.

Over the past decade, external support to Moldova grew. In 2012 it accounted for approximately $500 million per year (Figure 2.4). Approximately 6 percent of external funds was targeted for health and population policies, and 1 percent was targeted specifically for HIV/AIDS. In 2012 external support for HIV/AIDS was US$5.8 million, and for health and population was US$28.7 million.

Figure 2.4 External assistance disbursement, 2002–12

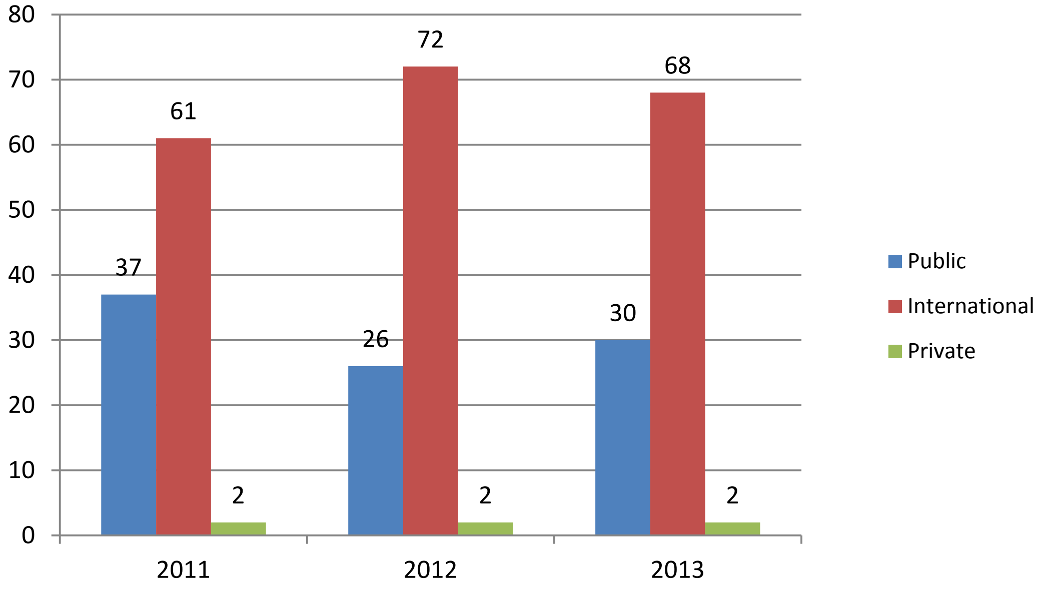


Source: OECD, CRS, 2014.

Although government spends a considerable share of its total expenditure on health, the Moldova **HIV response budget is moderate** compared to other countries in the Region. The HIV response in the country is **heavily dependent on international support.** In 2013 government expenditure on HIV comprised US$2,459,879 (30 percent); international resources constituted US$5,503,307 (68 percent); and private national resources allocated to HIV programs were US$173,357 (2 percent) (Figure 2.5). From 2012 to 2013, public financial resources increased by 7.6 percent, from US$2,381,695 to US$2,459,879, respectively. Conversely, compared to 2012, expenditures for the HIV response in 2013 **decreased** by 8.6

percent to US$8,136,543. The lower total is explained by the reduction of external or international resources by 14.8 percent. At US$8.1 million, HIV spending represents 0.8 percent of Moldova's total expenditure on health (US$937 million) in 2013.

Figure 2.5 HIV expenditure by the type of funding, 2011–13 (%)



Source: UNAIDS 2014. AIDSinfo database. http://www.unaids.org/en/dataanalysis/datatools/aidsinfo.

In 2013, of the total HIV response budget, approximately 40 percent was allocated to the treatment and care program, 27 percent for prevention, 18 percent for program management, 8 percent for social mitigation, 4 percent for human resources, 2 percent for enabling environment, and 1 percent for research.

To cover the National HIV Program deficit, Moldova was awarded a grant from the Global Fund as per its New Funding Model of a total of EUR 11.5 million for 2015–17. Of the total grant, 43 percent will be allocated for prevention; 38 percent for treatment, care, and support; and 10 percent for community capacity and sustainability.

The rest of this page is intentionally left blank.

3. METHODOLOGY: HOW WILL THIS REPORT ANSWER KEY QUESTIONS?

Chapter 3 outlines the main steps taken and tools applied to carry out the analyses presented in this report. Additional detail is available in appendixes A, B, and C.

3.1 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 in-country experts, Optima was calibrated to HIV prevalence data points available from the different subpopulations (including FSW, PWID and MSM), 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. 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 contained in appendix A.

3.2 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 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. There, national experts and specialists from international partners including worked together with mathematical modelers from UNSW to carry out modelling analyses using the Matlab software package. This Regional process also aimed at data comparison and exchange, quality assurance, and development of capacities in HIV epidemic and response analysis using mathematical modelling techniques. Preliminary results were then consulted with government experts and other in-country partners and summarized in this report.

Optima is a flexible model that enables the user to decide which populations, programs, time frames, and funding levels to consider in a country analysis. Table 3.1 summarizes the main parameters, which were identified based on contextual, epidemiological, national strategic, programmatic, and funding information and agreed with in-country stakeholders.

Table 3.1 Modeling parameterization

Category	Parameterization in Optima model	
Populations defined in model	**Right bank** · Females 15–49 · Males 15–49 · Female sex workers (FSW) · Clients of FSW (CSW) · Men having sex with men (MSM) · People who inject drugs (PWID)	**Left bank** · Females 15–49 · Males 15–49 · Female sex workers (FSW) · Clients of FSW (CSW) · Men having sex with men (MSM) · People who inject drugs (PWID)
Expenditure areas defined in model and included in optimization analysis	· FSW and client programs · MSM programs · NSP · OST	· FSW and client programs · MSM programs · NSP · OST
	Right and left banks · PMTCT · HIV testing and counselling · Antiretroviral therapy (ART) · Behavior change communication (BCC) and condom programs	
Expenditure areas not included in optimization	· Stigma reduction · Strategic information, Research, M&E · Management · STI control · Blood safety, Post-exposure prophylaxis, Precautions · Enabling environment · Training · Infrastructure · Social protection	
Time frames	Baseline: 2013 Modeling periods: 2015–20, 2015–30	
Baseline scenario funding	As per NASA for 2013	

Costs per person reached derived from coverage information and total spending on programs are presented in Table 3.2

Populations include **key populations,** which are defined around the dominant factor influencing transmission, and **general populations,** which are disaggregated by age and sex (excluding children).

Direct programs (included into optimization). Direct programs have a direct effect on HIV incidence or deaths and therefore could be included in the mathematical optimization analysis. For the expenditure areas selected for modeling, all prevention programs for the left and the right banks were included separately because there are considerable differences between their programs. The programs for FSW and clients and MSM, as well as OST, are not available on the left bank. Furthermore, the coverage levels differ for the two banks. For instance, as of 2013, on the right bank 42 percent of PWID were covered with NSP, whereas on the left bank only 8 percent were covered. Thus, prevention programs for MSM, PWID, FSW and clients, and OST on the right and left banks were included separately in the model. ART, PMTCT, HIV testing and counseling, and behavior change communication (BCC) and condom programs were included as single interventions operating on both banks.

Indirect programs (not included in optimization). Programs included in this category are part of the response, but their effect on HIV incidence and mortality is not clear or cannot be quantified. The total amount spent for these interventions remains fixed for different scenarios run within the modeling. Since these management and other costs already account for over 33 percent of HIV response costs, it was assumed that these programs would continue at their current level of funding.[6] The indirect programs are stigma reduction, strategic information, research, M&E, management, STI control, blood safety, post-exposure prophylaxis, precautions, enabling environment, training, infrastructure and social protection.

Time frames include baseline year and time period for modeling the results of changed allocations. For this study, the baseline year is 2013; the time periods for modeling are 2015–20 and 2015–30.

Baseline scenario funding represents current allocation as described in the 2013 National AIDS Spending Assessment (NASA).

Costs per person reached in Table 3.2 have some comparison limitations. For example, although all of the calculations are based on NASA/GARPR reporting, the calculation methodology applied could have differed among countries. The range of services included in service packages could be different as well. In other words, higher unit cost may not necessarily mean lower technical efficiency but also could imply that the package is more comprehensive. The big-picture comparison of unit cost shows that exploring possible technical efficiency gains would be useful, particularly for OST and ART.

Table 3.2 Unit costs established in the analysis

Cost per person reached	Moldova(%)		Regional comparison (6 countries incl. Moldova RB) (%)			
	Right bank	Left bank	Lowest	Highest	Average	Median
FSW programs	41.66	n/a	41.66	166.24	102.94	105.35
MSM programs	23.67	n/a	23.67	449.13	159.45	71.25
PWID-NSP programs	40.90	42.04	40.90	129.25	109.73	84.11
OST	935.15	n/a	31.41	1,645.24	747.36	790.23
PMTCT*)	738.08	544.18	738.08	8,905.27	4,616.80	4,267.59
ART)**	1,264.12	826.64	576.48	2,278.52	1,203.26	1,127.29

Source: Populated Optima data entry spreadsheets from 6 countries.
Note: *=Total program cost divided by the number of HIV-positive pregnant women receiving ARV prophylaxis/ART; **=Average cost per person on ART (including first and subsequent lines of treatment and clinical visits, which explains differences in costs between the two subregions despite the fact that commodity costs are the same).

3.3 Limitations of analysis

- There are some gaps in data, particularly for MSM and FSW and clients populations on the left bank of the Nistru River. As in other models, estimates of HIV prevalence in the general population were derived from data for pregnant women as a proxy for prevalence in the general population.
- The analysis used past ratios of expenditure-to-coverage as the basis for determining program cost rather than unit costs from a costing of future programs. Using past cost and

6 This assumption would require additional, more nuanced analysis, which goes beyond the scope of this study. Some management costs are expected to grow with scale, while technical efficiencies will emerge in other areas. Here it was assumed that a balance of such increases and reductions is feasible, considering that reductions also are achieved in the programs included in the optimization.

results has a number of advantages over using projected costs from plans and budgets, which, ultimately, are predictions of future cost. However, this past-cost approach also has a disadvantage: there may be future cost increases or decreases in relation to new approaches, implementation arrangements, or technologies.

- The modeling approach used to calculate relative cost-effectiveness among programs includes assumptions about the impact of increases or decreases in their funding. These assumptions are based on unit costs 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 is that increased spending could cause some saturation in the possible effect of programs.
- The analysis did not determine the technical efficiency of programs. Gains in technical efficiency would lead to different unit costs and therefore affect resource allocation.
- Modeling 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 systematic global literature review,[7] they 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 nevertheless have important functions in the HIV response, they have been treated as fixed costs and, in some specific scenarios, adjusted with specific justifications.
- Effects outside the HIV endpoints—including non-health benefits of OST, effects of needle exchange on hepatitis, and effects of condoms on contraception and STIs—are complex to consider. Given that, for OST, the majority of benefits are beyond HIV outcomes, specific consideration was given to the non-HIV benefits of OST (appendix A). However, 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; or ethical, legal, or psychosocial implications but to acknowledge that these are important aspects to be considered.
- Other models may not always produce exactly the same projections as those produced by Optima. The analysts used the best possible data, the combined experience from model application in over 20 countries, and Regional comparison and validation of inputs through comparison of different sources including data from clinical records, surveillance, and research.

---

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

4. RESULTS AND THEIR INTERPRETATION

This section presents the findings of the analyses, beginning with epidemic analysis and then moving into optimization analysis as well as related cost-effectiveness analysis.

4.1 What is the current status of the HIV epidemic in Moldova?

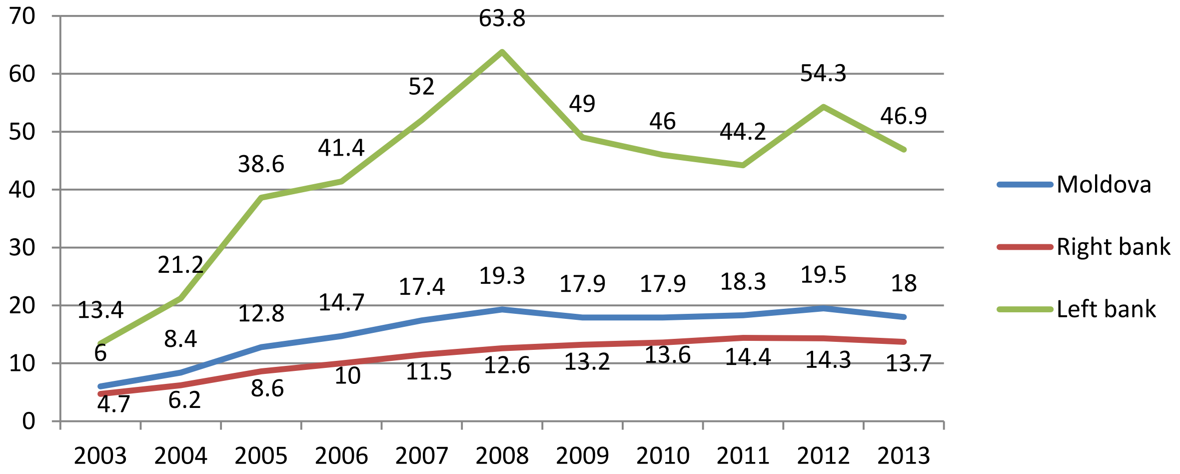
A summary of key national data on the HIV epidemic is provided in Table 4.1. It illustrates the rapid growth of the epidemic between 2000 and 2010 and then the slowing of epidemic growth approximately in 2010.

Table 4.1 Summary of key national data on HIV, 2000–13

		2000	2005	2010	2011	2012	2013	Source
HIV diagnoses								
Cumulative number of people diagnosed with HIV, total	Total	1,211	2,789	6,346	7,064	7,825	8,534	HTC program records
	Right bank	1,100	2,169	4,310	4,799	5,282	5,749	
	Left bank	111	620	2,036	2,265	2,543	2,785	
Cumulative registered number of people diagnosed with HIV and alive, total	Total	1,150	2,530	5,481	5,993	6,478	6,994	
	Right bank	1,043	1,920	3,573	3,936	4,218	4,551	
	Left bank	107	610	1,908	2,057	2,260	2,443	
New diagnoses								
Number of people newly diagnosed with HIV, total	Total	175	532	702	715	762	706	HTC program records
	Right bank	167	310	461	489	483	467	
	Left bank	8	222	241	226	279	239	
Service coverage and utilization								
Number of people receiving ART	Total	0	180	1275	1666	2075	2493	UNGASS
	Right bank	0	125	905	1185	1406	1633	
	Left bank	0	55	370	481	669	800	
Coverage of ART (receiving ART as a % of registered PLHIV)	Right bank	–	6.5	25.3	30.1	33.3	35.9	
	Left bank	–	9.0	19.4	23.4	29.6	32.7	
Coverage of ART (receiving ART as a % of estimated PLHIV)	Right bank	–	1.6	9.9	12.7	14.7	16.7	
	Left bank	–	2.1	8.3	10.3	13.7	15.8	
Heterosexual HIV transmission	Right bank	–	–	–	88.3	88.3	91.5	HTC program records
	Left bank	–	–	–	83.7	83.9	91.1	
HIV transmission through drug injection	Right bank	–	–	–	8.2	5.3	4.1	
	Left bank	–	–	–	9.3	6.2	6.5	
Vertical HIV transmission	Right bank	–	–	–	3.5	1.8	2.2	
	Left bank	–	–	–	1.3	1.1	2.4	

By the end of 2013, over 8,500 HIV diagnoses had been registered in Moldova since 1987. In 2013 there were **706 newly registered** cases of HIV after a rapid increase in HIV incidence in the 2000s. The number of newly registered cases of HIV peaked in 2008, with some stabilization at the beginning of the 2010s. The total number of PLHIV receiving ART by the end of 2013 was 2,493, which represents fewer than 20 percent of PLHIV covered. The epidemic in Moldova continues to be **concentrated** among key populations, mostly people who inject drugs (PWID), with an increasing incidence among female sex workers (FSW) and men having sex with men (MSM). Over the last 5 years, sexual transmission became the most common self-reported mode of HIV acquisition. In 2013, 92 percent of people who were newly diagnosed with HIV self-reported sexual transmission as the most probable route. Figure 4.1 shows the annual rate of newly diagnosed PLHIV per 100,000 population on the right bank and left bank of the Nistru River. The data suggest that, since 2004, new diagnoses consistently had been more than three times higher on the left bank.

Figure 4.1 Newly diagnosed PLHIV per 100,000 population, 2003–13



Source: Moldova Ministry of Health: National HTC records.

4.2 What are the expected trends if current conditions are maintained?

Based on the available data, the model was calibrated as described in appendix B and produced the HIV epidemic estimates summarized in Table 4.2. The estimates suggest that in 2014, there were 13,200 PLHIV in Moldova, a number that is consistent with the registered number of PLHIV and moderately lower than the estimated number of PLHIV in the Spectrum model used to produce national and global HIV estimates (UNAIDS 2015). Assuming that current conditions (current behaviors and program coverage) are maintained, the PLHIV population is projected to grow to 17,700 PLHIV by 2020. The estimated number of new infections in 2014 was 1,400, and, assuming that current conditions apply, this number is projected to grow to 1,700 by 2020. Estimated AIDS-related deaths were approximately 580 in 2014 and are projected to grow to 680.

Table 4.2 Summary of HIV epidemic estimates and projections for Moldova, 2014 and 2020

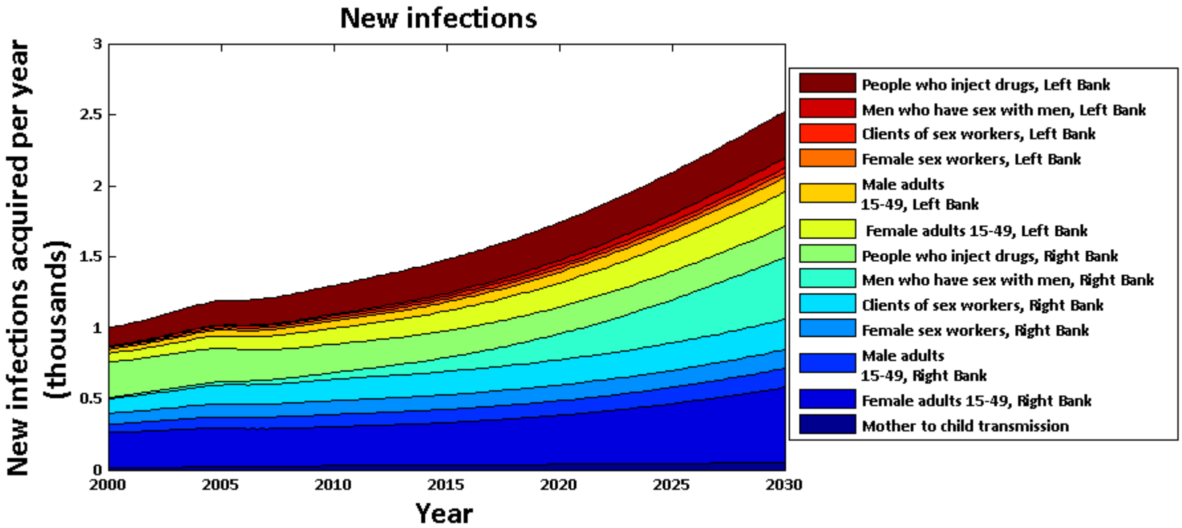
	PLHIV		Prevalence		New infections		AIDS deaths	
	2014	**2020**	**2014**	**2020**	**2014**	**2020**	**2014**	**2020**
Children	200	200	<0.1	<0.1	<10	<10	<10	<10
Female adults 15-49, Right Bank	3,100	4,000	0.3	0.4	290	350	130	150
Male adults 15-49, Right Bank	1,300	1,800	0.2	0.2	90	100	60	70
Female sex workers, Right Bank	800	1,000	7.7	8.3	100	110	30	40
Clients of sex workers, Right Bank	1,200	1,500	1.3	1.5	160	180	50	60
Men who have sex with men, Right Bank	400	1,000	4.2	10.6	80	190	10	40
People who inject drugs, Right Bank	2,400	2,500	11.9	11.3	190	190	110	90
Female adults 15-49, Left Bank	1,100	1,700	0.8	1.1	130	170	50	70
Male adults 15-49, Left Bank	600	900	0.6	0.8	60	80	30	40
Female sex workers, Left Bank	200	200	7.3	9.1	20	30	<10	<10
Clients of sex workers, Left Bank	100	200	1.2	1.5	20	20	<10	<10
Men who have sex with men, Left Bank	<100	200	3.3	7.1	20	30	<10	<10
People who inject drugs, Left Bank	1800	2,500	17.6	21.7	220	270	80	100
Overall	**13,200**	**17,700**	**0.5**	**0.6**	**1,400**	**1,700**	**580**	**680**

Source: Populated Optima model for Moldova.

The model-predicted evolution of new HIV infections in different populations is presented in Figure 4.2. The projections are made assuming that all programs receive 2013 funding between now and 2030. This projection suggests that the epidemic would grow continuously and that the annual number of new infections would grow by over 67 percent by 2030 (from 1,400 new infections in 2015 to approximately 2,500 new infections in 2030). **On the right bank,** the HIV epidemic among MSM is projected to be the fastest growing segment of the epidemic because annual new infections will triple by 2030. HIV incidence among other key populations likely is to be stable in the medium term. **On the left bank,** the model also suggests an increase in new infections among MSM and a moderate increase in new infections among FSW and their clients and PWID.

The results show that, currently, new infections among the **general population** represent approximately one third of the total annual incidence on both banks and a large portion of these infections is among female sexual partners of PWID, MSM and FSW clients. The number of infections are projected to increase among both female and male adults on the left bank, and in female adults on the right bank.

Figure 4.2 Model-predicted evolution of annual HIV incidence, 2000–30



Source: Populated Optima model for Moldova.

4.3 How will outcomes improve by optimizing allocations under the current level of funding?

Optimization analyses were carried out for different levels of funding and different policy questions in line with the agreed Scope of Work document. Results show some variations for different policy questions, but also indicate some overarching trends. When interpreting the results, readers should keep in mind that all management cost and other costs for related health services were kept stable and were not included in the mathematical optimization.[8] All optimization analyses suggest that there is room for substantial improvement of current allocations among the program areas, as detailed below.

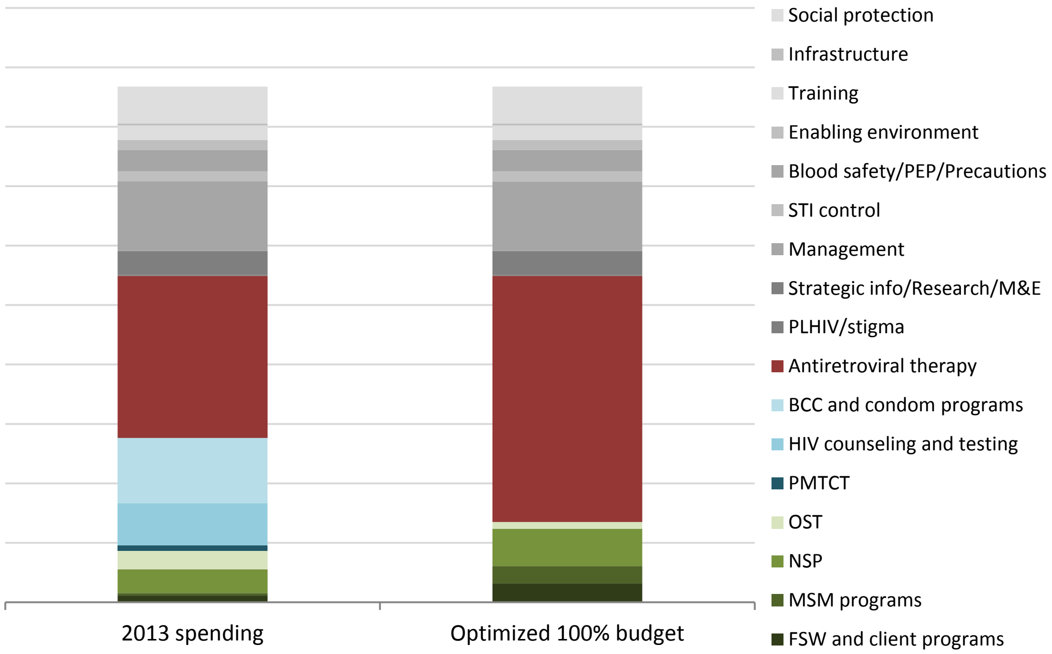
The first optimization presented here describes optimized allocations with constant 2013-level HIV funding available up to 2020.

The analysis suggests that optimized allocation of currently available resources could avert 20 percent of deaths and 16 percent of new infections. The largest reallocation proposed with constant levels of funding is to **prioritize ART** by increasing funding from approximately US$2.7 million to US$4.1 million (Figure 4.3), resulting in an increase of coverage from 23 percent to 35 percent. A rough comparison of ART unit costs in the Region shows that Moldova implements its treatment program slightly above average and median costs. This finding suggests that there could be some efficiency gains within the program to increase value for money. On the left bank, the annual treatment cost per person in 2013 was $826, vs. $1,264 on the right bank, suggesting the potential for unit cost reduction on the right bank.

Similar to other concentrated epidemics, in Moldova the model suggests **discontinuing provision of services for the general population**. HIV testing and counselling as well as BCC and condom programs for the general population were not part of the optimized allocation at the 2013 level of spending. These interventions currently account for over 20 percent of investment, or US$1.8 million per year—a substantial amount to be reallocated. HTC is part of programs for key populations and also received increased allocations. This finding should not imply stopping HTC, but strengthening the targeting of HTC. The model is indicating that, with limited resources and given unit costs, it will be most cost effective to initiate already diagnosed PLHIV on ART and provide HTC to key populations.

8 See appendix A for details.

Figure 4.3 Current vs. optimized allocation of 2013 funding to minimize HIV incidence and deaths (US$ million)



Source: Populated Optima model for Moldova.

Table 4.3 Allocations and coverage of programs with current allocations and optimized allocations at current levels of funding (100 % of 2013 spending)

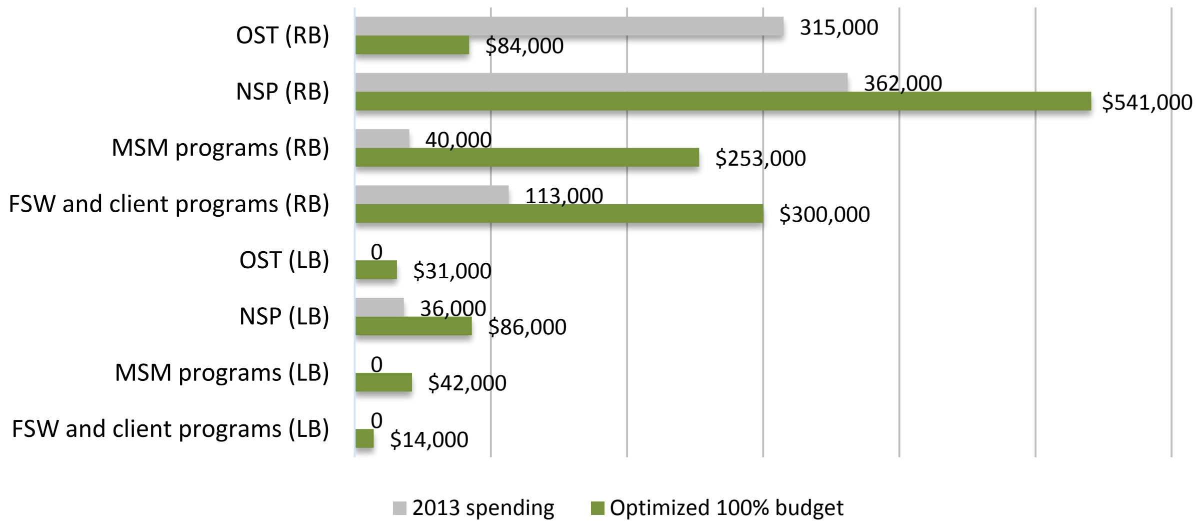
Analysis from 2015 to 2020	Current allocations 2015–20		Optimized allocations 2015–20	
	Current (US$)	Coverage (%)	Optimal (US$)	Coverage (%)
Programs for key populations (RB)				
(RB) FSW and client programs	113,000	29	300,000	61
(RB) MSM programs	40,000	21	253,000	82
(RB) NSP	362,000	41	541,000	52
(RB) OST	315,000	3	84,000	1
Programs for key populations (LB)				
(LB) FSW and client programs	0	0	14,000	15
(LB) MSM programs	0	0	42,000	62
(LB) NSP	36,000	60	86,000	70
(LB) OST	0	0	31,000	1
Programs for all populations (RB and LB)				
PMTCT	96,000	84	0[a]	0
HIV testing and counseling	703,000	23	0[b]	0
Antiretroviral therapy	2,726,000	2,996 (23% of all PLHIV)	4,139,000	4,549 (35% of all PLHIV)
BCC and condom programs	1,100,000	58	0	0

Source: Populated Optima model for Moldova.

Note: a=Pregnant women should continue to be covered with ART as part of the increased ART budget. In practice, this would also require continued HIV testing and counseling for pregnant women, which could be financed from maternal health budgets; b=HIV testing and counseling would continue to be provided as part of programs for key populations. As discussed below, persons requesting to be tested for HIV should continue to receive the service, even if they are not part of key populations. What the model suggests is that, from a cost-effectiveness perspective, expanded testing for the general population is not among the most cost-effective programs when no additional resources are available.

Optimized allocations also provide funds for **scale-up of three prevention interventions** on the **left bank**, and **scale-up prevention for key populations** on the **right bank**. Prevention services for PWID, FSW, and MSM should receive significantly more funding on both banks of the Nistru River, with NSP receiving the biggest share of funds on both banks (Figure 4.4). Although OST currently is not available on the left bank, the model suggests introducing **OST** to the left bank by providing $31,000 of annual funding to this program. On the right bank, according to the modeling results, current budgets allocate slightly less funding to OST than originally budgeted. However, this fact should not be seen as a recommendation to decrease coverage of OST. This finding is due to the fact that this optimization seeks to minimize both new infections and deaths. Since there is no alternative to ART for reducing death in the medium term, high allocations are given to ART despite relatively high unit cost. For reducing new infections, the model allocated limited resources to the most cost-effective programs, which for PWID in this context was the NSP program. Moldova has relatively low unit cost for other prevention programs, but—according to a big-picture comparison of costs per person reached—relatively high **OST unit cost** compared to other countries in the Region. In the 6 countries included in the analysis, OST unit cost averages US$747; whereas in Moldova OST is currently provided at a unit cost of US$935 (INSERM and UNAIDS 2015). This large difference suggests possible technical efficiency gains in the OST program could be explored.

Figure 4.4 Reallocation of funds for HIV prevention services at 2013 level (US$)



Source: Populated Optima model for Moldova.

4.4 What could be gained from increased funding and how should reduced funding be prioritized?

The results in this section are optimized allocations for different levels of funding available ranging from 0 percent to 200 percent of current spending on direct programs with the goal to minimize both HIV incidence and deaths. In this optimization, the level of spending on management, enablers, and other costs has been kept stable.

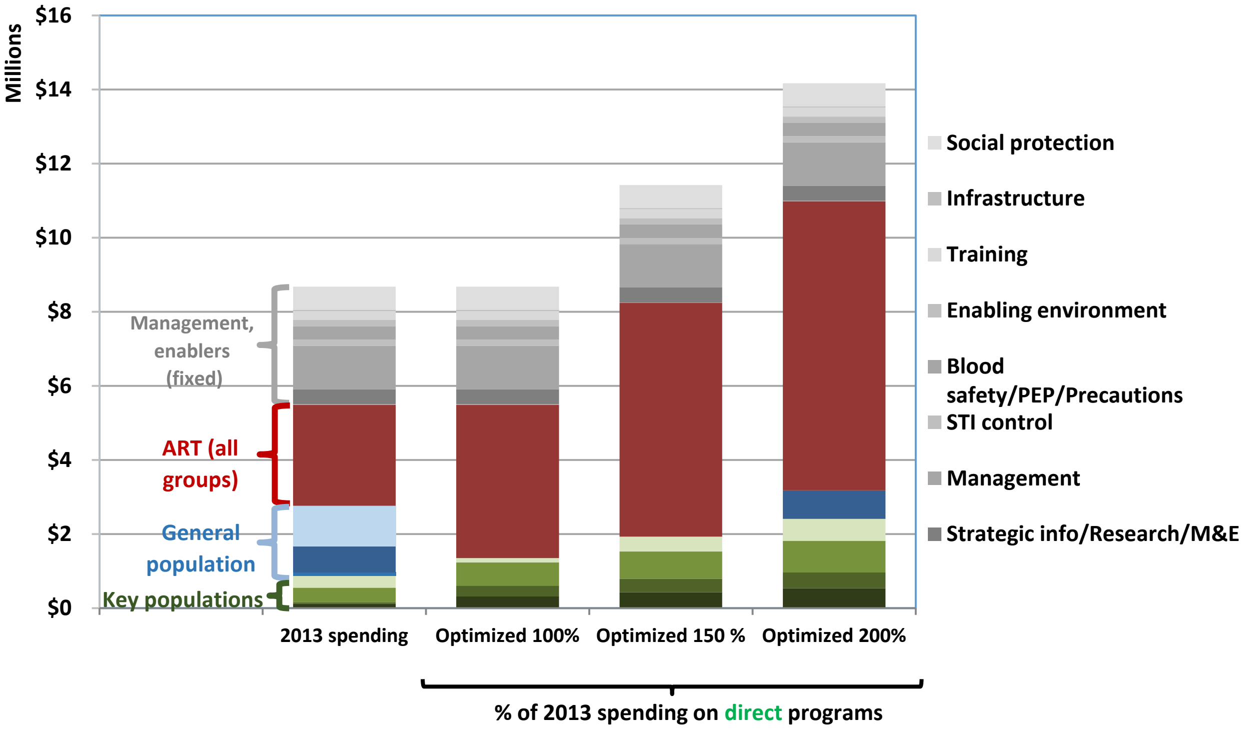
At all levels of funding, provision of ART for PLHIV requires the largest funding allocations. In case of budget reductions, compared to the current level of spending, the key interventions would be ART and prevention for key populations including PWID, MSM, and FSW and their clients. With additional funds available, the funds should be invested in **continuous increase of ART** and prevention programs for key populations.[9] At the current level of budget

[9] Detailed data on level of funding for each program area, as well as the estimated number of new infections and deaths appears in appendix 4.

availability, the model suggests to stop all prevention services for the general population. With 200 percent of budget availability, HIV HTC is recommended to receive approximately 7 percent of the budget (US$0.8 million). This allocation is required because, to increase ART coverage further, HIV testing needs to be provided beyond key populations.

The optimization analysis was carried out for 2 different time frames—2015–20 and 2015–30—to test whether substantial differences in allocations exist. However, the overall trend remained the same. Detailed allocations for all funding levels from 0 percent to 200 percent are detailed in appendix D. Since the contextual analysis established that HIV funding in Moldova has been relatively low and that the treatment gap is substantial, the results in Figure 4.5 focus on possible scenarios to increase HIV funding.

Figure 4.5 Optimized allocations to minimize HIV infections and HIV-attributable deaths at different budget levels, 2015–20



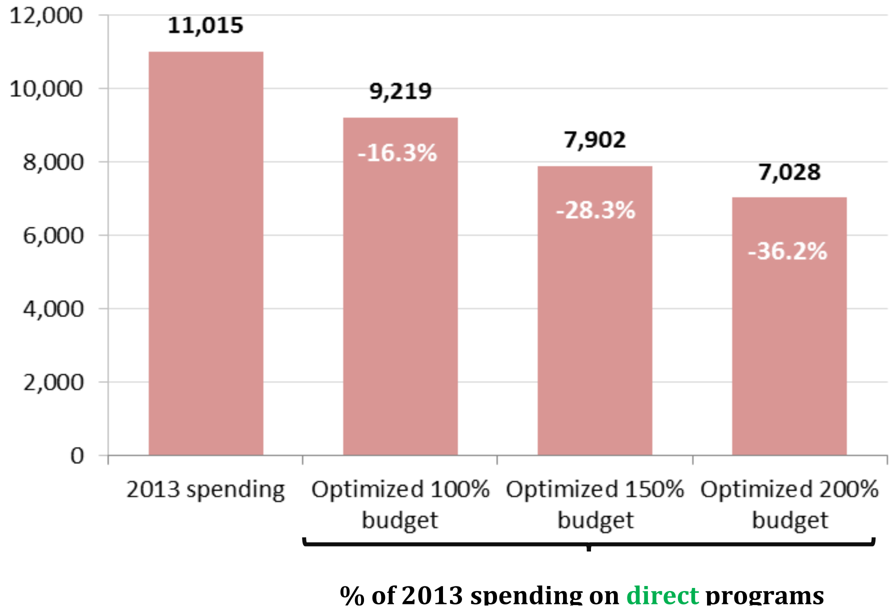
Source: Populated Optima model for Moldova.

Note: Only optimized costs are scaled. Non-optimized spending remains at current levels; BCC=behavior change communication; FSW=female sex worker; MSM=men who have sex with men; NSP=needle and syringe exchange program; OST=opiate substitution therapy; PLHIV=people living with HIV; PMTCT=prevention of mother-to-child transmission; STI=sexually transmitted infections.

The level of available funding and focus of allocations would have a substantial effect on the **number of new infections** in Moldova. Assuming there were no funding starting from 2015, by 2020 there would be cumulatively approximately 18,000 new infections. With the current level of funding and current allocation, there would be approximately 11,000 new infections in 6 years (Figure 4.6). In contrast, optimizing the current budget would reduce the cumulative number of new infections to 9,200 cases in 5 years—a decrease of incidence of 16 percent. **Doubling the 2013 budget for direct programs and allocating it optimally would decrease new infections to 7,000 during same period—a decrease in incidence of 36 percent compared to the baseline scenario.**

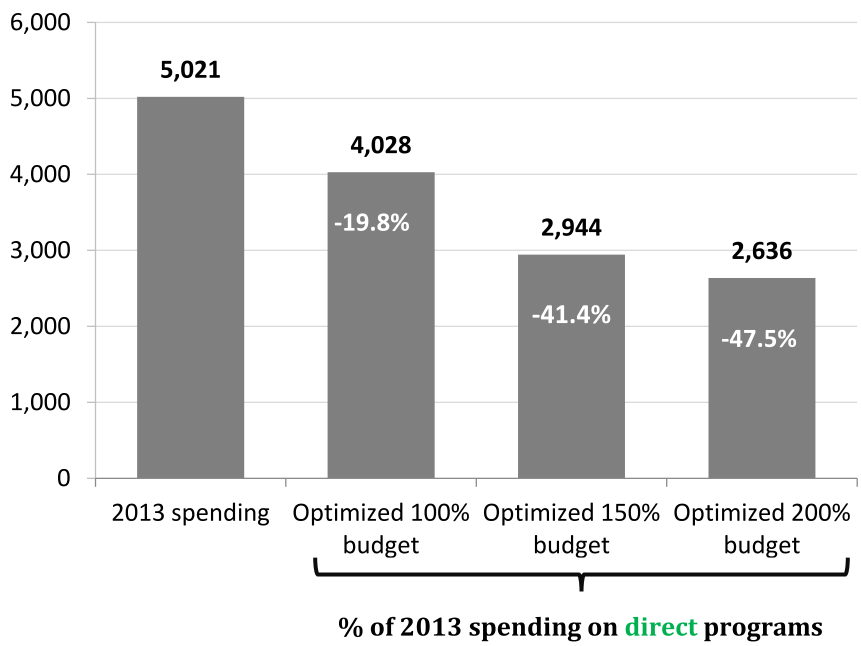
If starting from 2015 funding for the HIV response were not available, there would be approximately 7,000 **HIV-related deaths** by 2020. With the current allocation and level of spending, the estimated number of cumulative HIV-related deaths would be approximately 5,000 by 2020 (Figure 4.7). Optimization of current spending could reduce the cumulative number of deaths by 1,000 (to 4,000 deaths in 5 years, or a 20 percent reduction). **Availability of 200 percent of the 2013 budget for direct programs could reduce HIV-related deaths to approximately 2,600 (a 48 percent reduction compared to the baseline scenario).** Table 4.4 provides the actual levels of funding for different programs and corresponding impacts.

Figure 4.6 Cumulative new infections at different levels of budget availability, 2015–20



Source: Populated Optima model for Moldova.

Figure 4.7 Cumulative number of HIV-related deaths at different levels of budget availability, 2015–20



Source: Populated Optima model for Moldova.

Table 4.4 Distribution of HIV prevention and treatment spending to reduce new infections and HIV-related deaths, 2015–20 (US$)

Program/Indicator	2013 allocations	Optimized 100% of 2013 program spending	Optimized 150% of 2013 program spending	Optimized 200% of 2013 program spending
Direct programs (US$)				
FSW and client programs (RB)	113,000	300,000	380,000	463,000
MSM programs (RB)	40,000	253,000	304,000	354,000
NSP(RB)	362,000	541,000	646,000	759,000
OST (RB)	315,000	84,000	234,000	350,000
FSW and client programs (LB)	0	14,000	48,000	71,000
MSM programs (LB)	0	42,000	59,000	74,000
NSP(LB)	36,000	86,000	90,000	97,000
OST (LB)	0	31,000	167,000	241,000
PMTCT	96,000	0	0	0
HIV testing and counselling	703,000	0	0	770,000
Antiretroviral therapy	2,726,000	4,139,000	6,308,000	7,804,000
BCC and condom programs	1,100,000	0	0	0
Subtotal direct programs	**5,491,000**	**5,490,000**	**8,236,000**	**10,983,000**
Indirect programs (US$)				
PLHIV/stigma	15,000	15,000	15,000	15,000
Strategic info/Research/M&E	403,000	403,000	403,000	403,000
Management	1,174,000	1,174,000	1,174,000	1,174,000
STI control	165,000	165,000	165,000	165,000
Blood safety/PEP/Precautions	363,000	363,000	363,000	363,000
Enabling environment	168,000	168,000	168,000	168,000
Training	243,000	243,000	243,000	243,000
Infrastructure	33,000	33,000	33,000	33,000
Social protection	622,000	622,000	622,000	622,000
Subtotal indirect programs	**3,186,000**	**3,186,000**	**3,186,000**	**3,186,000**
Total spending (US$)	**8,677,000**	**8,676,000**	**11,422,000**	**14,169,000**
Total 2013 spending (%)	**100**	**100**	**132**	**163**
Epidemiological outcomes				
Cumulative new Infections	11,000	9,200	7,900	7,000
Cumulative AIDS-related deaths	5,000	4,000	2,900	2,600
		Coverage (%)		
Programs for key populations (RB)				
(RB) FSW and client programs	29	61	69	75
(RB) MSM programs	21	82	85	87
(RB) NSP	41	52	56	58
(RB) OST	3	1	3	3

Table 4.4 Distribution of HIV prevention and treatment spending to reduce new infections and HIV-related deaths, 2015–20 (US$) *(Continued)*

Programs for key populations (LB)				
(LB) FSW and client programs	0	15	44	56
(LB) MSM programs	0	62	75	81
(LB) NSP	60	70	70	70
(LB) OST	0	1	3	4
Programs for all populations (RB and LB)				
PMTCT	84	0a	0	0
HIV testing and counselling	23	0b	0	25
Antiretroviral therapy	2,996 (23% of all PLHIV)	4,549 (35% of all PLHIV)	6,932 (53% of all PLHIV)	8,576 (65% of all PLHIV)
BCC and condom programs	58	0	0	0

Source: Populated Optima model for Moldova.

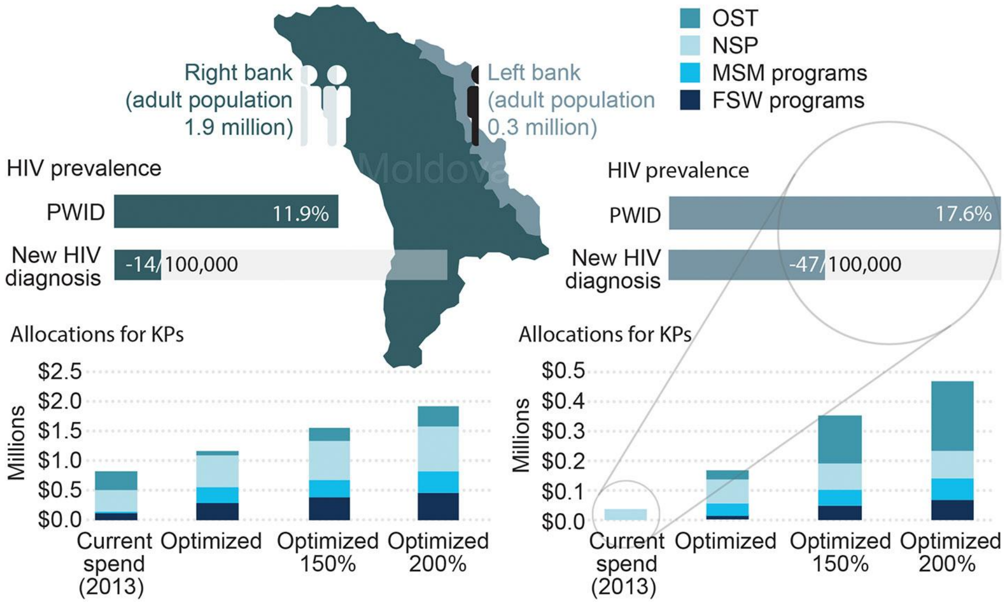
Note: Amounts rounded to the nearest US$1,000*;* **a=**Pregnant women should continue to be covered by ART as part of the increased ART budget. In practice, this coverage also would require continued HIV testing and counseling for pregnant women, which could be financed from maternal health budgets*;* b=HIV testing and counseling would continue to be provided as part of programs for key populations. As discussed below, persons requesting to be tested for HIV should continue to receive the service even if they are not part of key populations. What the model suggests is that, from a cost-effectiveness perspective, expanded testing for the general population is not among the most cost-effective programs when no additional resources are available.

The large increase and relatively large share of spending allocated to ART is due to a combination of factors. As mentioned, ART is without alternative for reducing death in the short and medium terms and reduces new infections. In addition, ART unit cost in Moldova, particularly for the right bank, is above average. If the ART unit cost could be reduced, substantially more funding could be allocated to HIV prevention, even if less than 200 percent of current spending on direct programs is available. Programs for prevention of mother-to-child transmission (PMTCT) were not part of the optimized mix of interventions. Purely from a cost-effectiveness perspective, excluding them is common for concentrated epidemics because a large number of pregnant women must be tested to identify one HIV positive woman, leading to high cost per HIV infection averted. This reality does not mean that funding for PMTCT should be discontinued, but that HTC and ART for pregnant women should be provided at minimal cost by including and prioritizing pregnant women within the allocations for ART and HTC. Within the scenario for 200 percent of 2013 spending on direct programs (US$14.2 million), the increased allocations for these 2 programs could be partially used for continued HTC and ART access for pregnant women.

Optima also suggests substantial increases in programs for key populations: particularly OST and NSP on the left bank; and programs for FSW, MSM, and NSP on the right bank (table 4.4, figure 4.8). With the levels of funding available, there is also a proposed increase in funding for OST on the right bank. However, under current cost assumptions, the increase is only moderate. The relatively high unit cost for OST in Moldova has the opposite effect from ART in the model allocations. The model—using current unit cost assumptions—prioritizes NSP and other prevention programs for key populations due to their lower cost. However, as has been shown in other countries in the Region, where OST cost is relatively lower, OST can be cost effective with lower unit costs. To be able to expand OST, the unit costs for ART (because it absorbs the bulk of funding) and OST should be reviewed. As mentioned, considering OST's non-HIV benefits, scaling up OST is justified due to a number of health and social benefits and should be pursued in any case with cofinancing from different health and social sectors.

Figure 4.8 details the optimized allocations for prevention among key populations on the right bank and the left bank at different levels of available funding. As indicated above, new HIV diagnoses per 100,000 people are 3 times higher on the left bank as is HIV prevalence among both PWID and women in the general population. Nevertheless, current investment in HIV prevention for key populations on the left bank is limited. Regardless of the level of spending, Optima suggests substantially increasing prevention allocations for key populations, on both the left bank and the right bank, but the increases are more pronounced for the left bank.

Figure 4.8 Allocations for prevention programs among key populations in the two geographic subregions, the right bank and the left bank



Source: Populated Optima model for Moldova.

4.5 How much does it cost and how should resources be allocated to achieve national targets?

The optimizations presented in the previous sections sought to identify optimized allocations for given amounts of funding available while maximizing impact on new HIV infections and deaths. The optimization analysis presented in this section describes **optimized allocations to achieve a given impact** as specified in the national strategy, while minimizing the amount of money required to achieve this impact.

The **National Program for HIV/AIDS and STI Control and Prevention for 2011–15** was approved by the Moldovan Government on December 16, 2010. The targets of the National Program were described in section 1.2. Three of four national HIV prevalence targets— for PWID, FSW, and the general population—are **achievable** with optimized spending by year 2020 (Table 4.5). However, considering the epidemic's projected trajectory, the national target for HIV prevalence among MSM would not be achievable. With optimized resource allocation and current cost-coverage outcome assumptions, it would be possible to achieve only 7.6 percent HIV prevalence.

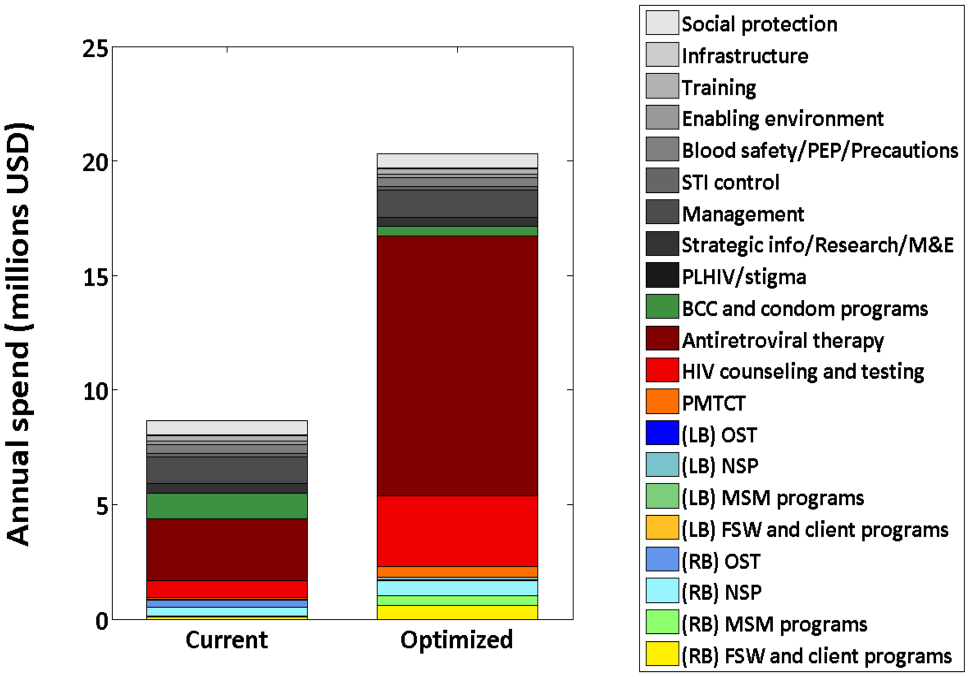
Table 4.5 National targets on prevalence vs. prevalence in case of optimized spending, 2020

Population	National target maximum prevalence (%)	HIV prevalence in 2020 Optimized spending scenario (%)
PWID	20.00	13.00
FSW	11.00	6.60
MSM	5.00	7.60
General population	0.44	0.36

Source: Populated Optima model for Moldova.

HIV prevalence targets on their own are ambiguous because they may be due to a reduction in new infections, or to an increase in deaths. Thus, for purposes of optimization analysis, to avoid the conclusion that the reduction in prevalence is achieved by an increase in deaths, the prevalence targets need to be translated into HIV incidence targets. For this reason, the national targets were expressed in form of a 40 percent reduction in HIV incidence by 2020. **To achieve national targets, substantial increases in funding beyond 200 percent of current spending would be required: a** budget of **US$20.3 million**[10] **against the 2013 budget of US$8.7 million** (Figure 4.9).

Figure 4.9 Minimum annual resource allocation required to achieve 2020 national strategy targets (US$ million)



Source: Populated Optima model for Moldova.

As for previous optimization analyses, the largest share of the increased budget for achievement of national targets on incidence will be allocated to ART (66 percent of optimized budget, or $11.3 million). This increase in funding would **increase coverage** from 2,700 to approximately 12,000 PLHIV. To achieve such high levels of coverage, a substantial increase in HTC would be required in parallel to increased allocations for prevention programs for key populations. Table 4.6 provides all the detailed funding allocations and corresponding coverage.

[10] Including $3.2 million of fixed cost, not included in the optimization. Only optimized costs are scaled. Nonoptimized spending remains at current levels.

Table 4.6 Cost and coverage required to achieve national targets, 2015–20

	Current allocations applied 2015–20		Optimized to achieve national targets 2015–20	
Analysis from 2015–20	**Current**	**Coverage**	**Optimized**	**Coverage**
Programs for key populations (RB)				
(RB) FSW and client programs	$113,000	29%	$579,000	>80%
(RB) MSM programs	$40,000	21%	$444,000	>80%
(RB) NSP	$362,000	41%	$659,000	56%
(RB) OST	$315,000	3%	0[a]	0%
Programs for key populations (RB)				
(LB) FSW and client programs	0	0%	0	0%
(LB) MSM programs	0	0%	$43,000	63%
(LB) NSP	$36,000	60%	$123,000	70%
(LB) OST	0	0%	0[a]	0%
Programs for all populations (RB and LB)				
PMTCT	$96,000	84%	$450,000	>90%
HIV testing and counselling	$703,000	23%	$3,101,000	73%
Antiretroviral therapy	$2,726,000	3,000 (23% of all PLHIV)	$11,316,000	12,000 (>80 % of all PLHIV)
BCC and condom programs	$1,100,000	58%	$417,000	25%
Subtotal direct programs	**$5,491,000**		**$17,132,000**	
Subtotal indirect programs	**$3,186,000**		**$3,186,000**	
Total spending	**8,677,000**		**20,318,000**	
% of total 2013 spending	**100%**		**234%**	

Source: Populated Optima model for Moldova.
Note: This finding does not suggest that OST programs should be defunded. It suggests only that the prevalence level proposed in the national target for PWID (and corresponding HIV incidence levels) could be achieved by focusing on NSP (in combination with treatment programs and other services reaching PWID). However, as other optimizations to maximize impact on HIV incidence and deaths have shown, OST is essential to be sustained and scaled up.

4.6 What are the health and financial impacts of implementing different ART guidelines?

ART was introduced in Moldova in 2002. By the end of 2013, 2,500 people were on treatment. However, using the eligibility criterion for treatment of CD4 count <350 cells/mm^3, the estimated need was more than twice that, at 6,600. In this context, the government committed to increase treatment coverage and increase its share of ART program funding.

The study team carried out an analysis to establish the effect of a test and treat approach, which would imply that all PLHIV are eligible to begin treatment regardless of their CD4 count. The results presented here are for the following test and treat scenario:

- 70 percent of all PLHIV diagnosed by 2020
- 90 percent of those diagnosed on ART by 2020
- 90 percent of those on ART with viral suppression by 2020.

The analysis (Table 4.7) suggests that a test and treat approach would have a positive impact on both new infections and deaths averted.[11] **Compared to current levels of treatment coverage, applying a test and treat approach would enable reducing HIV incidence by 36**

[11] The comparison is done for the baseline scenario: the number of people on treatment in 2013 with no additional scale-up.

percent by 2020 and by 30 percent by 2030. In total, by 2020, the new eligibility criteria would avert 3,000 new infections and 2,400 deaths. Considering a longer period (2015–30), the cumulative number of averted infections would be 11,900; and the cumulative number of averted deaths, 8,000. Introducing new eligibility criteria is projected to cost an additional average US$6.1 million per year, resulting in US$30.5 million of additional funding needed by 2020, and US$91.5 million by 2030.

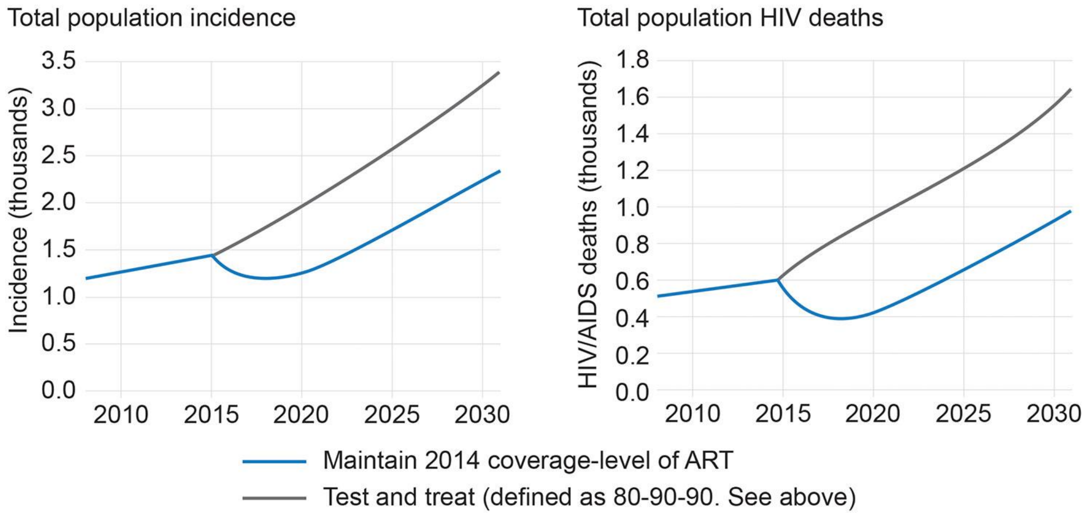
Table 4.7 Comparing the impact of different ART eligibility for PLHIV, 2020 and 2030

Impact measures	Scale-up compared to no scale-up	
	By 2020	By 2030
HIV incidence (compared to baseline scenario) reduced (%)	35.6	30.4
Number of new HIV infections averted	3,000	11,900
Number of AIDS-related deaths averted	2,400	8,000
Additional cost per year ($)	6,101,000	6,101,000
Total additional cost per given timeframe ($)	**30,505,000**	**91,515,000**

Source: Populated Optima model for Moldova.

The impact of the test and treat approach on the epidemic was analyzed assuming that other behaviors and other programs remain constant from 2015 onwards. Using the current coverage of other programs and current numbers of PLHIV on ART, the model suggests that the annual number of new infections and deaths will continue to grow between 2015 and 2030 (Figure 4.10). Scaling up the treatment program will reduce incidence and deaths in the medium term (by 2020). However, in the long term from 2020, incidence and mortality will continue to increase by more than 50 percent by 2030 compared to 2013 levels. This projection suggests that, to stabilize the epidemic, continued ART scale-up beyond 2020 and other programs remain important, particularly for key populations, including PWID, FSW, and MSM.

Figure 4.10 Projected new HIV infections and AIDS-related deaths with current ART coverage and a test and treat approach in Moldova, 2010–30



Source: Populated Optima model for Moldova.

The team also compared ***(a) the impact of a scenario with increased ART eligibility as the only change to optimized allocations*** with ***(b) minimizing both incidence and deaths with funding at a level of 200 percent of 2013 spending on direct programs,*** which corresponds to 163 percent of the 2013 budget, or US$14.2 million. This comparison suggests that the ***combined scale-up*** of different programs will have better results and require less funding. Table 4.8 illustrates that an optimized mix of a combination of programs would avert 56 percent more new infections and 17 percent more deaths, compared to exclusively scaling up treatment. As mentioned above, ART would remain a focus of the combined scale-up of programs and receive 71 percent of funding for direct programs, which is 55 percent of the total HIV spending. However, other prevention interventions for key populations will remain essential to maximize impact, particularly on new infections.

Table 4.8 Comparing the impact of ART scale-up and 200 percent budget availability scenario up to 2030

	ART scale-up only scenario	Optimized mix for a combination of programs (200% of 2013 direct program spending)
Cumulative number of new HIV infections averted	11,900	18,600
Cumulative number of AIDS-related deaths averted	8,000	9,400
Additional cost per year	$6,101,000	$5,490,000[a]
Total additional cost per given timeframe	**$91,515,000**	**$82,350,000**

Source: Populated Optima model for Moldova.

Note: [a]=Only the cost included in optimization is used to calculate the 200%. Thus, additional cost is calculated presuming that management, stigma reduction cost, and costs for other program areas will not be increased.

The rest of this page is intentionally left blank.

5. CONCLUSIONS AND RECOMMENDATIONS

The following are key conclusions and recommendations from this study:

1 **Moldova's HIV epidemic remains concentrated among key populations (PWID, FSW, and MSM) and their sexual partners.** Available data suggest that the epidemic has transitioned from an early concentrated epidemic in which the highest rates of transmission were among PWID; to an advanced concentrated epidemic, in which onward transmission to sexual partners of PWID and other key populations has become a large source of new infections. Because Moldova's HIV epidemic is projected to keep growing, it is critical to keep monitoring epidemic trends among key populations and their sexual partners. Data gaps on HIV prevalence among key populations such as FSW and MSM, particularly on the left bank, should be filled by including sites on the left bank in bio-behavioral surveillance studies for these groups.

2 **Moldova should continue to prioritize ART scale-up, which is essential to minimize both HIV incidence and HIV-related deaths.** Depending on the amount of funding available, ART spending should account for 50 percent–70 percent of all HIV spending. With current funding, to reduce deaths by 20 percent by 2020, ART coverage should increase from less than 20 percent in 2013 to 35 percent of all PLHIV. If total HIV spending could be increased from US$8.7 million to over US$14.0 million between 2015–20, a 3-fold increase in ART spending and coverage is recommended. Compared to business as usual (2013 funding), this increase would expand ART coverage to 65 percent of all PLHIV and avert 48 percent of AIDS-related deaths. Also compared to business as usual, scaling up a test and treat approach would reduce new infections by 36 percent. However, overall, it would be less effective than a combined scale-up of ART plus prevention for key populations.[12]

3 **HIV testing and counselling is a critical component of programs for key populations at all levels of spending as an entry point for ART.** However, at current levels of funding, HTC for the general population is not cost effective. With increased availability of funding, to achieve high ART coverage beyond the already diagnosed PLHIV and key populations, expanding HTC beyond key populations will be required. Nevertheless, HTC still would remain focused on the geographic locations, in which partners of key populations and their partners are likely to be found. As noted above, PMTCT should be provided at minimal cost and focus on diagnosis of HIV in pregnant women that is integrated into comprehensive maternal health services with referral to ART services, thus avoiding overhead for PMTCT as a separate program.

[12] This finding is consistent with a cost-effectiveness analysis carried out in the Region, which showed that combined scale-up of ART and harm reduction programs would have the largest impact on HIV and HCV in Moldova. See INSERM and UNAIDS 2015.

4 **There is a need to focus prevention interventions on key populations and reallocate funding from general population prevention programs such as BCC to interventions that reach key populations**. At all levels of funding up to 200 percent of 2013 program spending, prevention for the general population (behavioral change communication and condom programs) should be replaced with targeted programs for PWID, MSM, and FSW and their clients. Particular attention should be paid to (a) MSM on the right bank because HIV prevalence is projected to increase from 4 percent in 2014 to 11 percent in 2020; and to (b) PWID on the left bank, among whom HIV prevalence already stood at an estimated 18 percent and is projected to increase to 21 percent by 2020.

5 **Given the severe HIV epidemic on the left bank of the River, prevention programs should be scaled up as soon as possible including through further increasing coverage of needle-and-syringe exchange programs, while introducing services for MSM and FSW, as well as OST.** These key prevention programs are not in place on the left bank, a region within Moldova in which general adult HIV prevalence is projected to increase beyond 1 percent according to Optima and to even higher levels according to the 2015 Spectrum estimates.

6 **Rapid assessments of technical efficiency of ART and OST programs should be carried out.** Although analysis of technical efficiency was not a part of this study, a Regional comparison of cost per person reached suggests that technical efficiency could be further improved in some program areas. While costs for some prevention programs for key populations appear comparably low in Moldova, costs for ART and OST are not. The intra-Regional differences require exploration within Moldova of specific areas for unit cost reductions, particularly for ART, which will absorb the majority of funding if programs are scaled up.

7 **Given the multiple health benefits of OST, additional cofinancing for OST and potentially other expenditures covered from HIV budgets should be sought from other social and health budget lines.** Management, enablers, and other costs, which are considered part of national HIV spending, include a number of areas whose scope goes beyond HIV programming. Examples are OST, blood safety, STI control, and social protection. A technical efficiency analysis of these costs and a review of funding sources would reveal whether the potential exists to reallocate funding to the high-impact programs prioritized in optimized allocation scenarios. Over the long term, in the context of transitioning to full national ownership and program sustainability, HIV programs should be integrated with the wider health response. Within that, HIV components of the budget would complement, rather than pay for, these services.

8 **By increasing investments in the HIV response, including domestic financing, Moldova could realize high returns in reducing deaths and improving lives by averting new HIV infections.** Although, in Moldova, HIV accounts for approximately 3.0 percent of disease burden in years of life lost (YLL), total annual spending on HIV accounted for only 0.8 percent of total health expenditure in 2013. In fact, 67 percent of funds for HIV programs came from international partners. This vast gap suggests the necessity for a substantial increase in domestic financing of the HIV response. Compared to current spending, increasing total HIV investment from US$8.7 million to US$14.2 million and optimally allocating resources would decrease incidence by 36 percent and HIV-related deaths by 48

percent. In the long term, these effects would have not only health benefits but also financial benefits in reduced health care cost for PLHIV.

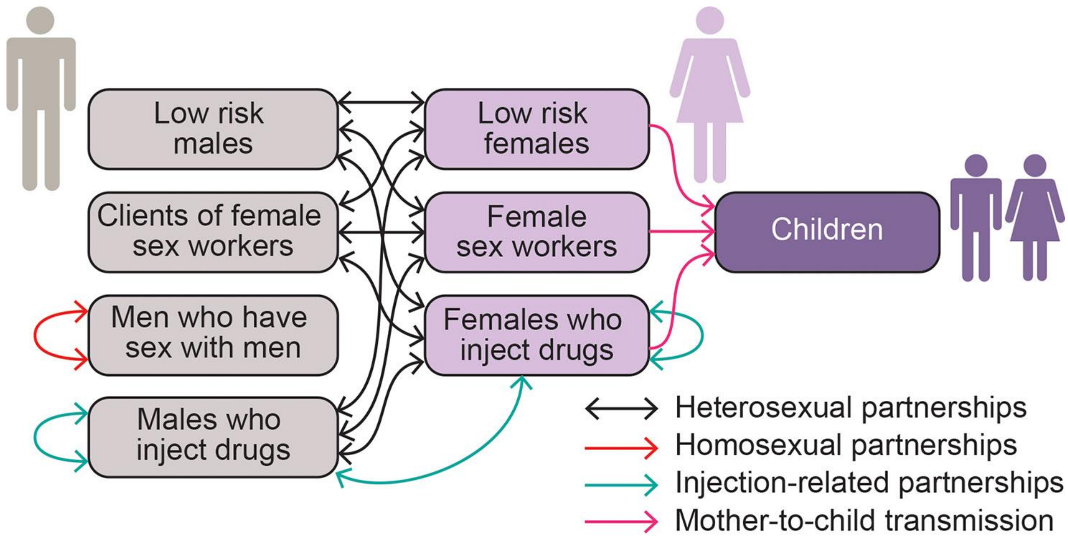
The rest of this page intentionally left blank.

APPENDIXES

APPENDIX A. TECHNICAL SUMMARY OF OPTIMA

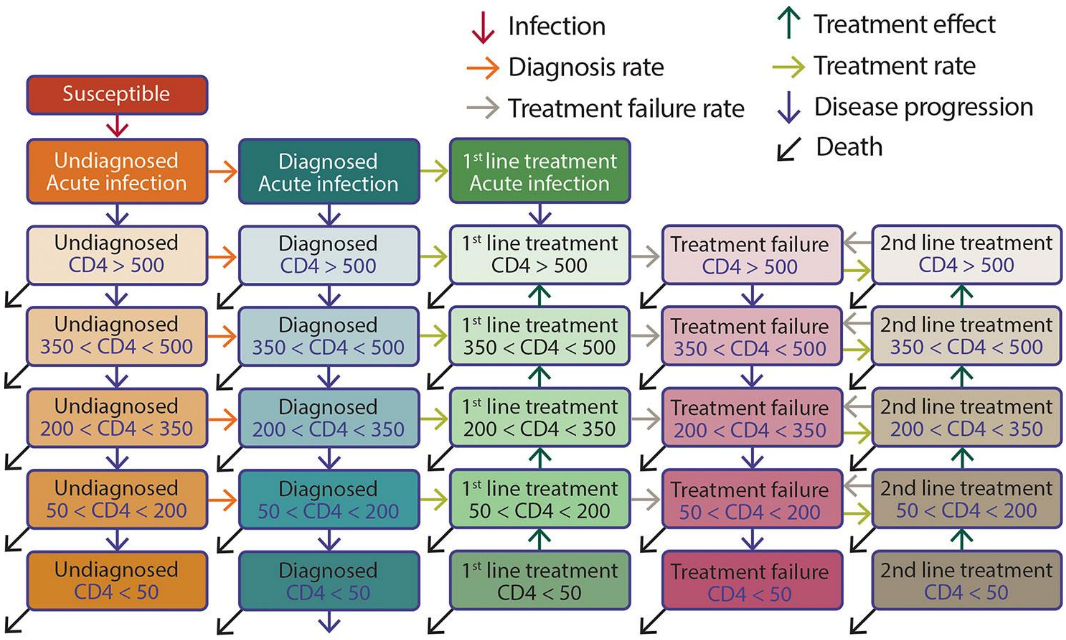
Appendix A provides a brief technical overview of Optima. A more detailed summary of the model and methods is provided elsewhere (Kerr and others 2015). Optima is based on a dynamic, population-based HIV model. Figure A.1a summarizes the populations and mixing patterns used in Optima. Figure A.1b shows 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.

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.

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.[13] 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 1) the same line as the l fl ri, and on the same lndividuals are exposed in a given period (either within their population groups or through interaction with other population groups) and the infection probabilthrough which HIV transmission may occur). The value of the 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

13 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).

for a given population will be the sum of all interaction types.[14] 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.[15]

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.[16]

---

14 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.

15 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.

16 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 $U_{FSW2002350}$ is the current number of undiagnosed HIV-positive FSW with a CD4 count between 200–350 cells per microliter; $U_{FSW3502500}$ 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.)

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)
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: Table prepared by 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.

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.

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.[17] 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 responses.[18] 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,

---

17 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).

18 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).

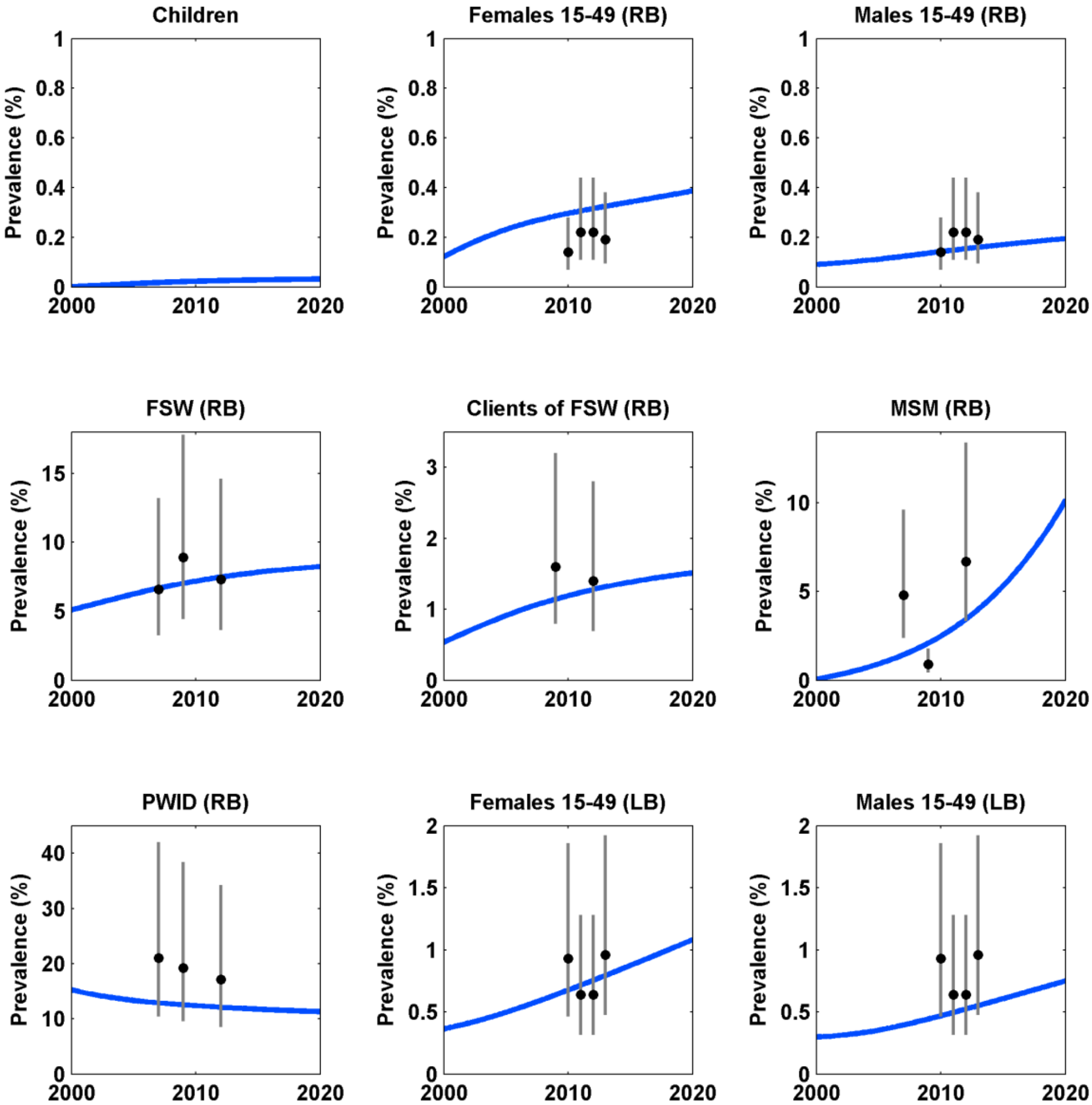
users define upper and lower limits for both coverage and behavior for no spending and for very high spending.[19]

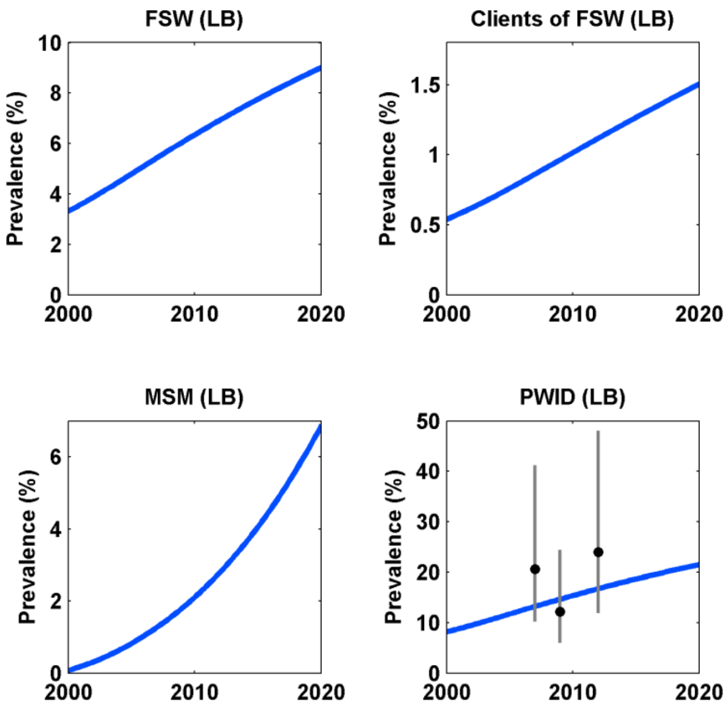
[19] All available historical spending data and achieved outcomes of spending, data from comparable settings, experience, and extensive discussion with stakeholders in the country of application can be used to inform these ranges. All logistic curves within these ranges then are allowable and are incorporated 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. CALIBRATION OF THE MODEL TO EPIDEMIC DATA

Using available demographic, epidemiological, behavioral, and clinical data (recorded in the Optima data entry spreadsheet), the team calibrated Optima to the HIV epidemic in Moldova over 2000–13 (Figure B.1 and Figure B.2). Based on the calibration, the team estimated the overall and population level incidence over 2000–20.

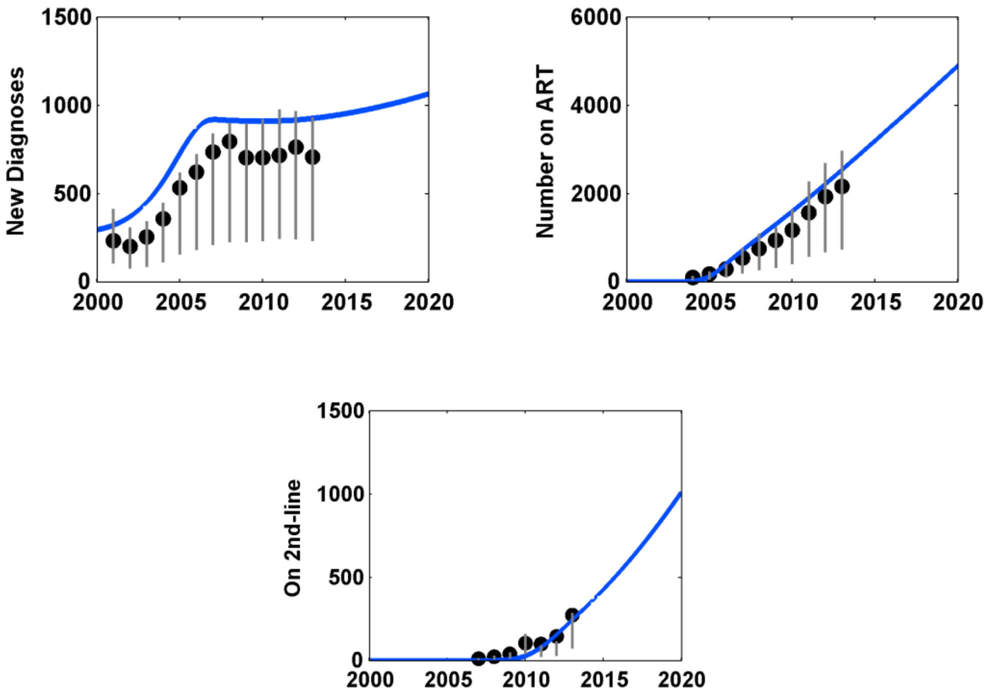
Figure B.1 Calibration of Optima model to the HIV epidemic in Moldova, 2000–20 (prevalence %)





Note: 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.

Figure B.2 Calibration of model to ART scale-up data in Moldova, 2000–20



Note: Black discs represent available data for the number of people on first- and second-line anti-retroviral treatment. Lines attached to these discs represent uncertainty bounds. The solid curve is the best-fitting simulation. The number on ART includes those on first-line ART who are experiencing treatment failure.

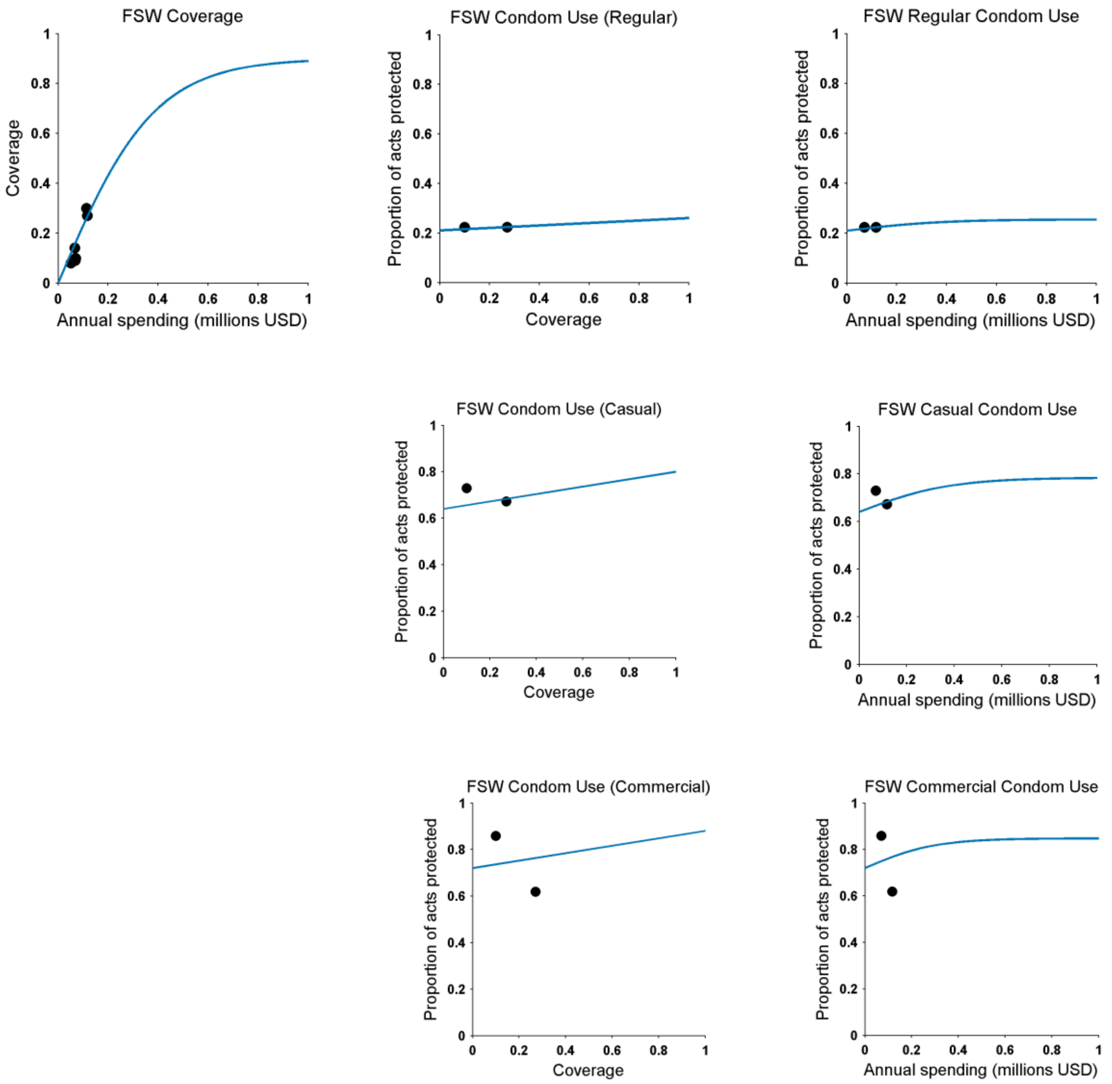
APPENDIX C. COST-COVERAGE-OUTCOME RELATIONSHIPS

Figure C.1 shows cost-coverage-outcome curves for HIV programs in Moldova. The relationship between program spending and coverage is shown in the left panel of subfigure C.1a. 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 would describe what proportion of female sex workers can be covered with an investment of US$0–US$1 million. The relationship between coverage level and outcome is shown in the right panel. This relationship describes the proportion of people who will adopt a specific behavior (such as condom use or consistent use of ARVs leading to viral suppression). These relationships were reached in collaboration with Moldovan experts.

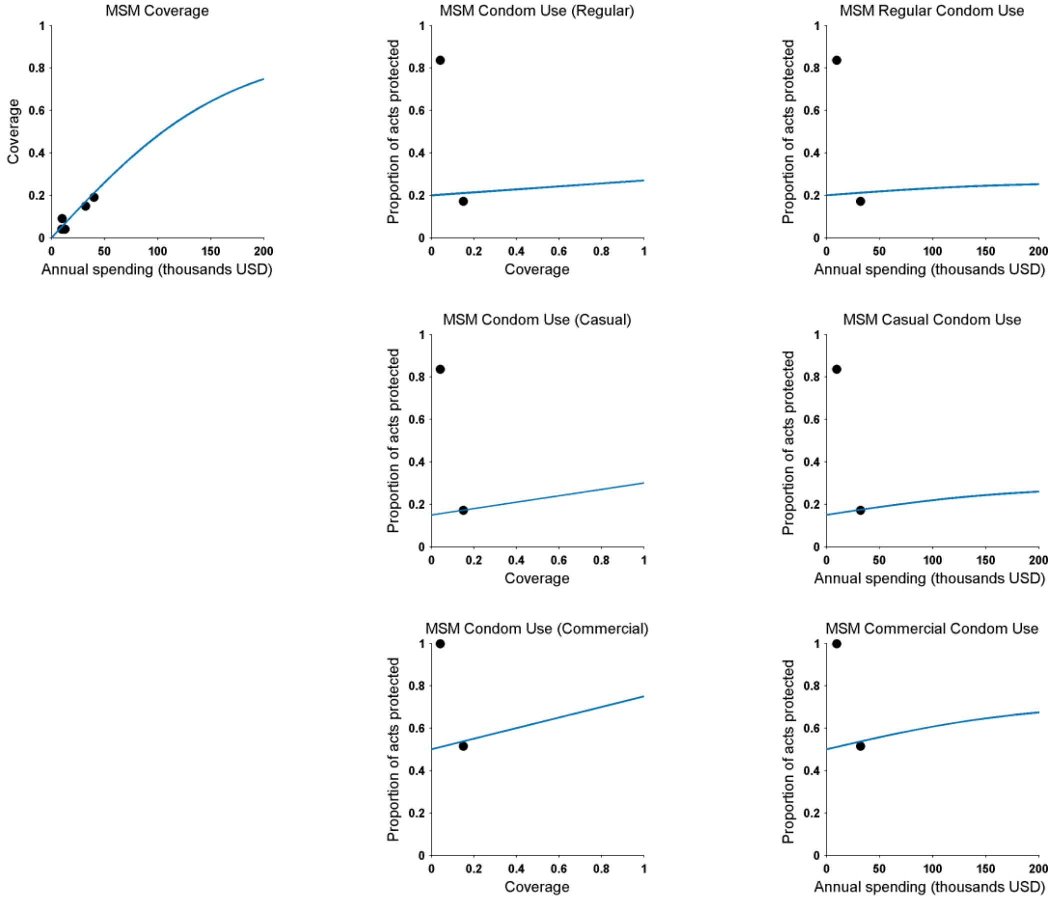
Figure C.1 Cost-coverage outcome curves for Moldova

C.1a Cost-coverage	Coverage-outcome	Cost-outcome

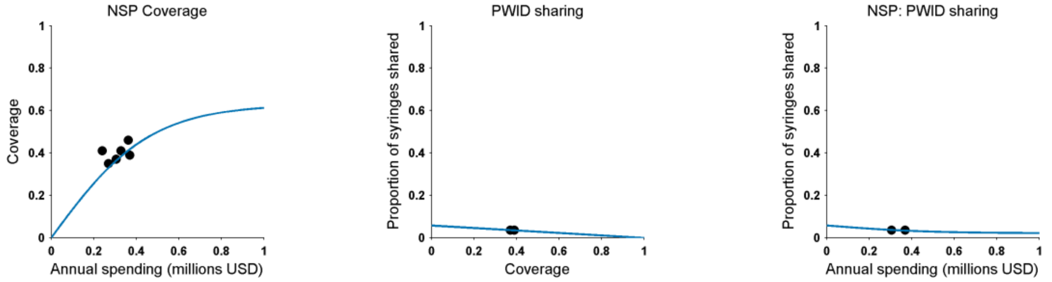
1. Female Sex Workers (FSW) and Client Programs (Right Bank)



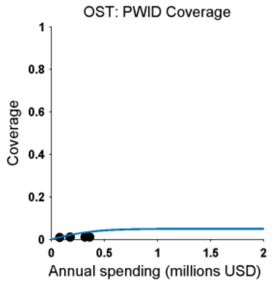
2. Men Having Sex with Men (MSM) Programs (Right Bank)



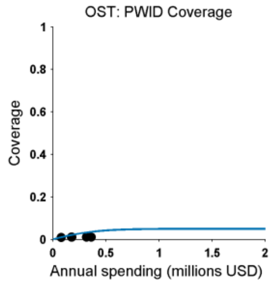
3. Needle-Syringe Program (NSP) (Right Bank)



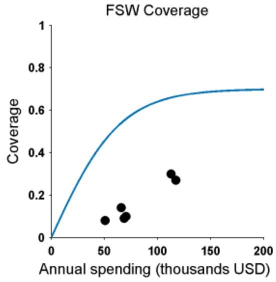
4. Opiate Substitution Therapy (OST) (Right Bank)

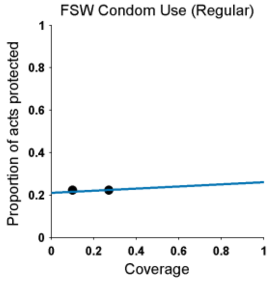


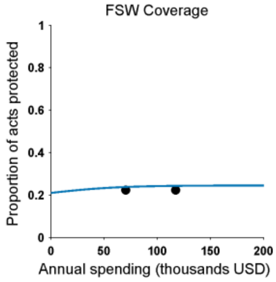
Not applicable

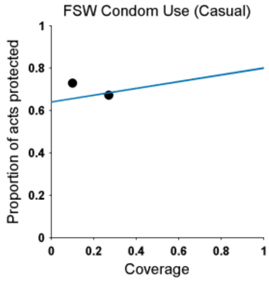


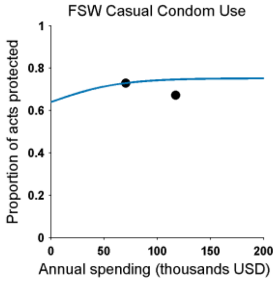
5. FSW and Client Programs (Left Bank)

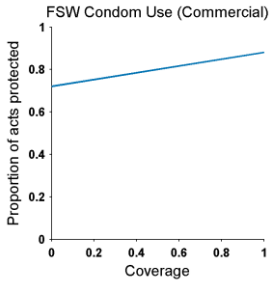






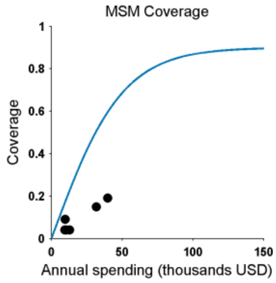


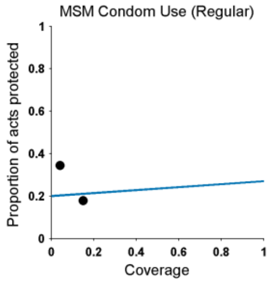


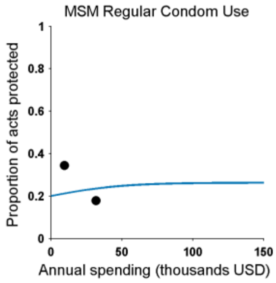


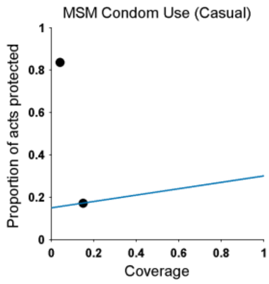
MSM_LB_Coverage

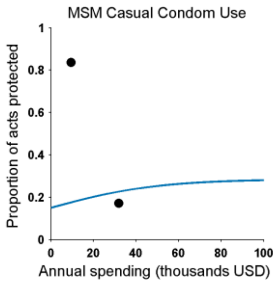
6. MSM Programs (Left Bank)

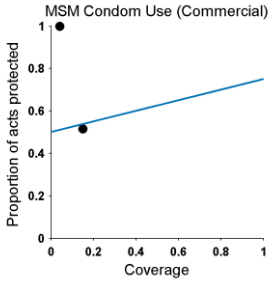






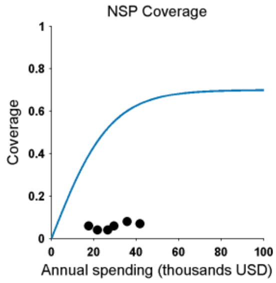


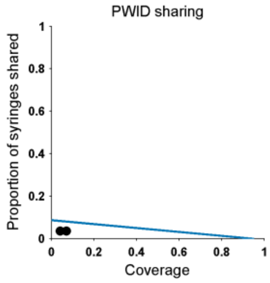


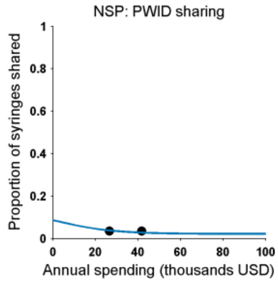


f

7. NSP (Left Bank)

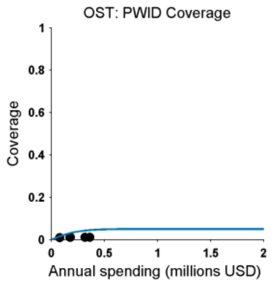


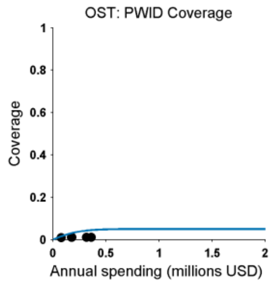




8. OST (Left Bank)

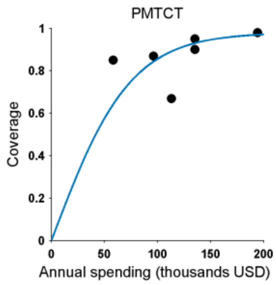
Not applicable

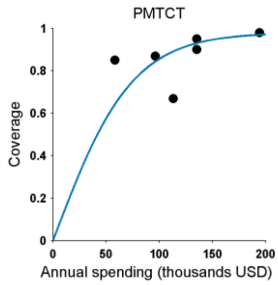




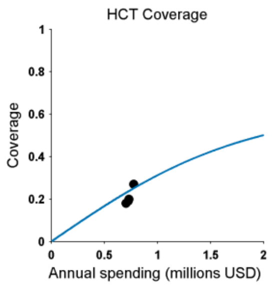
9. Prevention of Mother to Child Transmission (PMTCT)

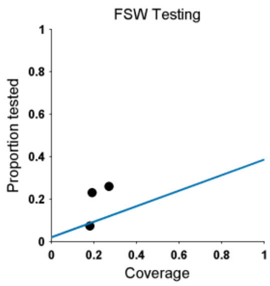
Not applicable

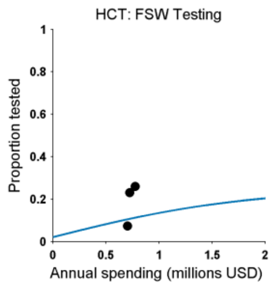


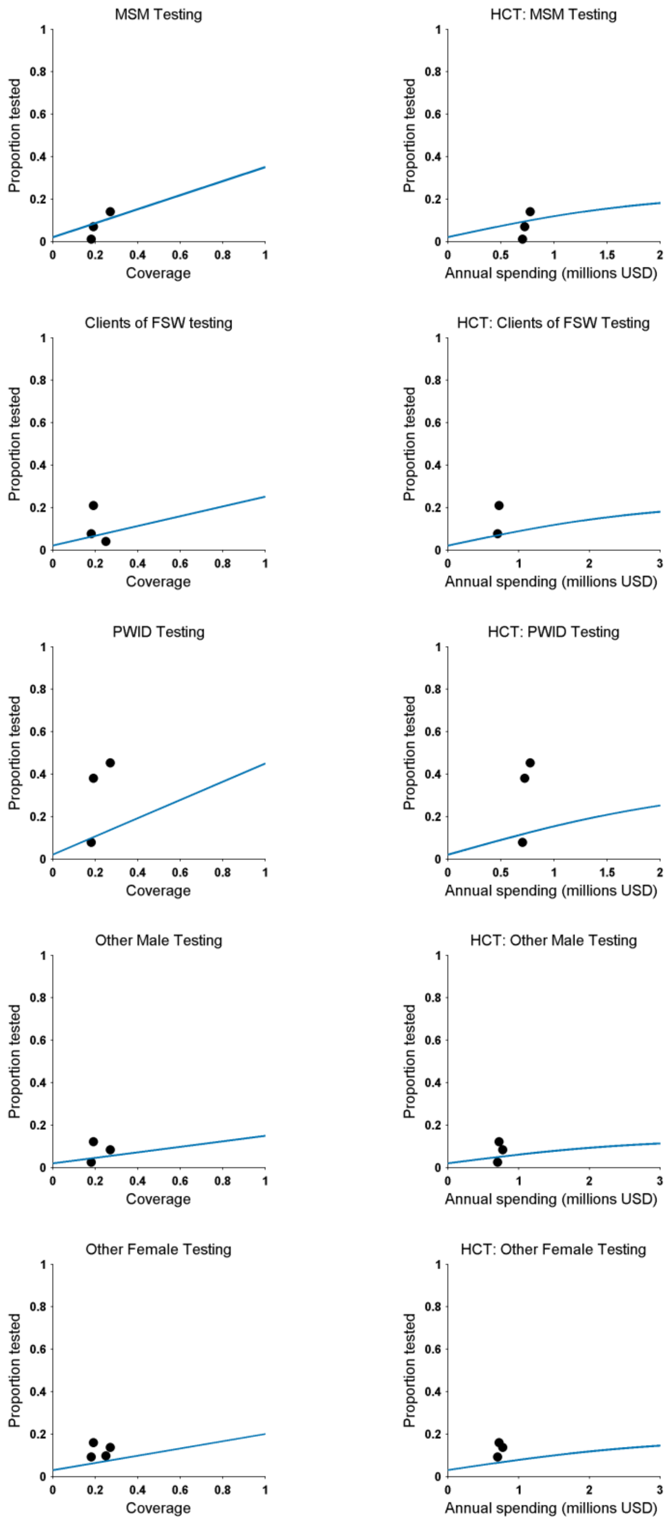


10. HIV Testing and Counseling (HCT)





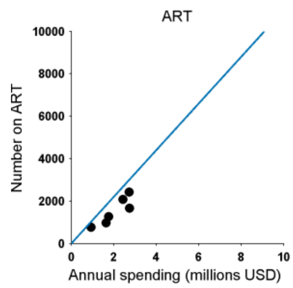




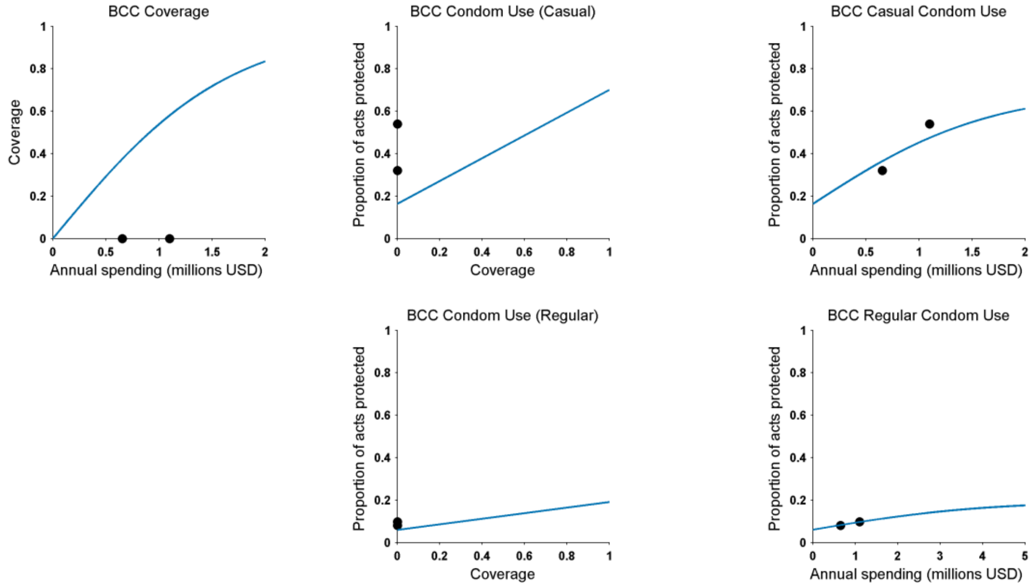
11. Antiretroviral Therapy (ART)

Not applicable

Not applicable



12. Behavior Change Communication (BCC)and Condom Programs



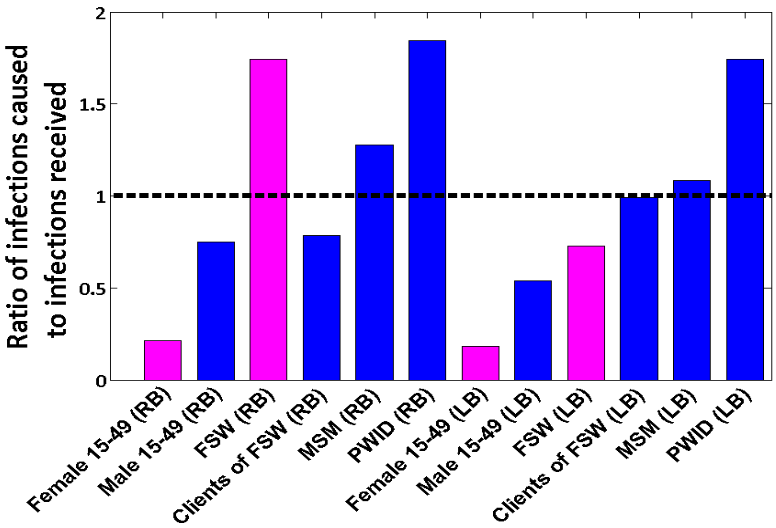
Note: Black discs represent available spending and coverage data and associated behaviors. The solid curves are the best fitting or assumed relationship.

APPENDIX D. ADDITIONAL RESULTS

Epidemiology

The populations included in modeling differ in the number of infections that they transmit and acquire. Figure D.1 illustrates which groups received more new infections than they transmitted (values below 1) and vice versa (values above 1). As of 2013, on the right bank, more new infections were transmitted by three key populations: PWID, FSW, and MSM. On the left bank, the biggest share of infections were transmitted by PWID.

Figure D.1 Ratios of HIV transmission (infections transmitted) vs. HIV acquisition (infections received) among populations, 2013



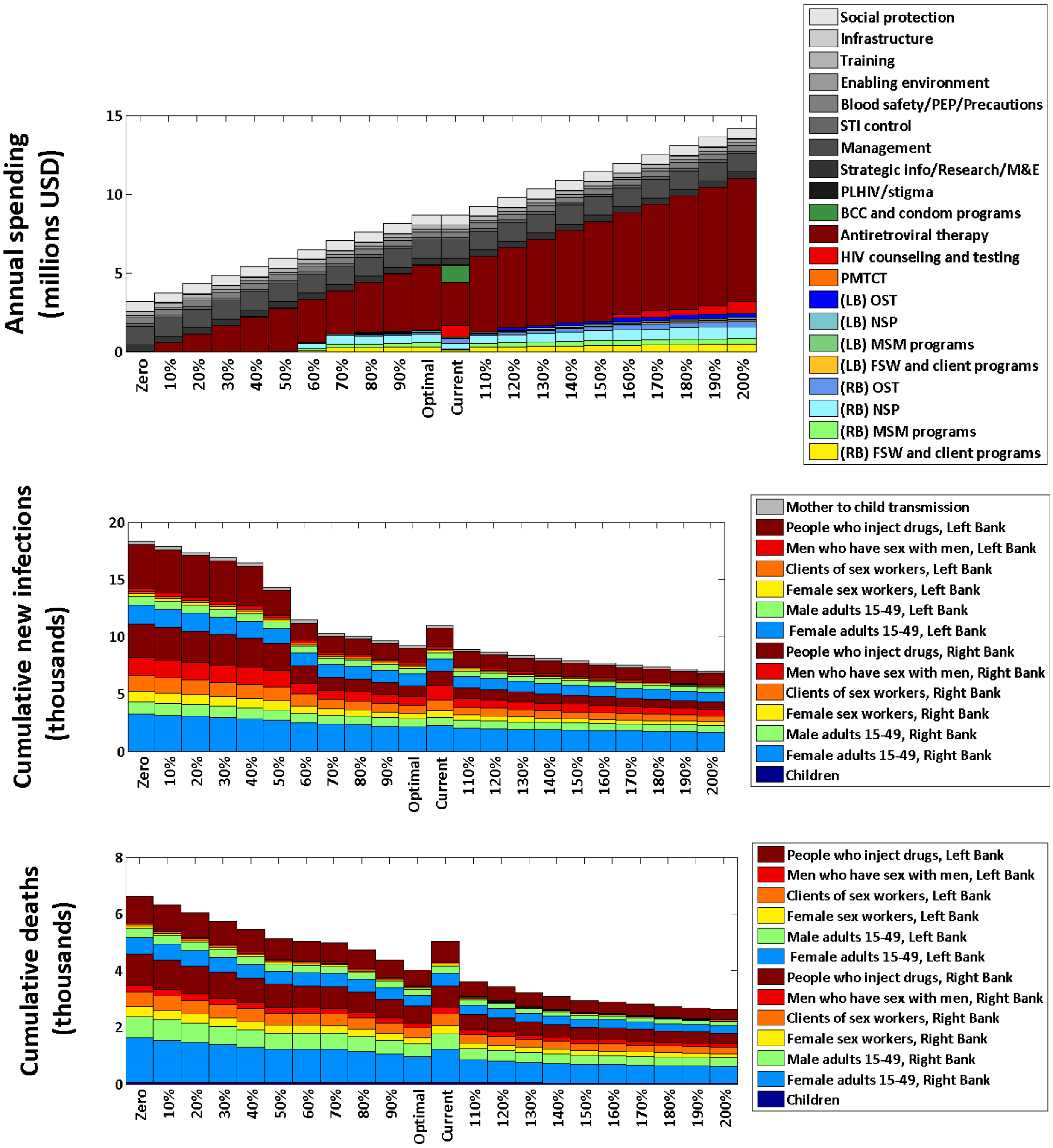
Source: Populated Optima model for Moldova.
Note: Female populations are in **pink**; male populations are in **blue**.

On the right bank, the increase in new infections among **female adults** likely was due to interactions with MSM, men who inject drugs, and clients of FSW. Clients of FSW received more infections than they transmitted. The vast majority of HIV infections that FSW clients received were from FSW. However, because many infections that the clients transmitted were to female adults in the general population, FSW clients remain an important bridging population. On the left bank, the high and increasing incidence among females likely was caused predominantly by contacts with men who inject drugs, with a contribution of contacts to clients of FSW and MSM.

Additional Optimization Results

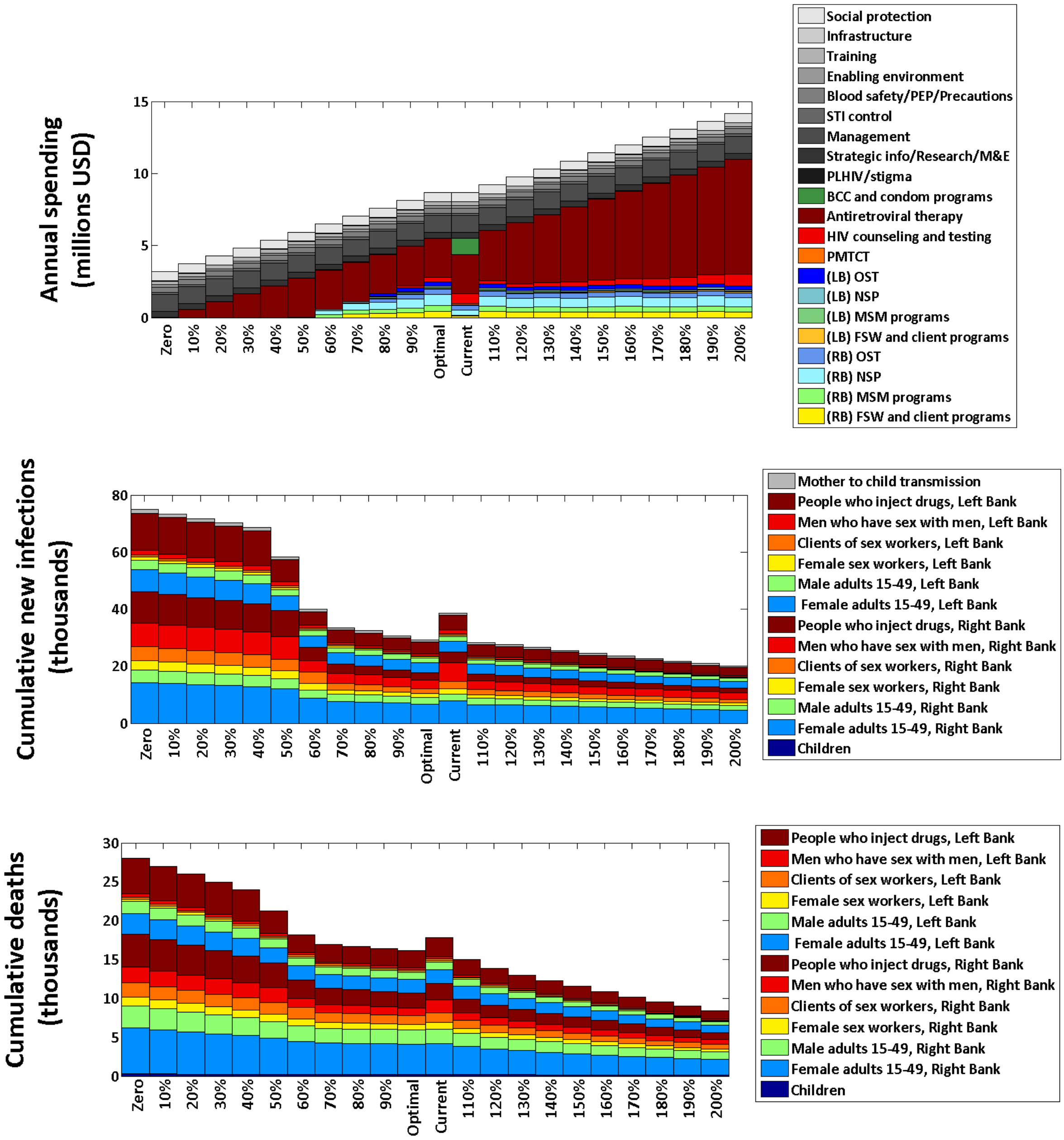
Figure D.2, Figure D.3, and Table D.1 present additional optimization results for different levels of HIV spending.

Figure D.2 Optimized allocations to minimize HIV infections and HIV-attributable deaths, 2015–20 at different budget levels (% of 2013 direct program spending)



Source: Populated Optima model for Moldova (for all 3 figures).
Note: Only optimized costs are scaled. Non-optimized spending remains at current levels.

Figure D.3 Optimized allocations to minimize HIV infections and HIV-attributable deaths by 2030 at different budget levels



Source: Populated Optima model for Moldova.
Note: Only optimized costs are scaled. Nonoptimized spending remains at current levels.

Table D.1 Distribution of HIV prevention and treatment annual spending to reduce new infections and HIV-related deaths, 2015–30

Program	2013 spending ($)	Optimized 50% budget ($)	Optimized 100% budget ($)	Optimized 150% budget ($)	Optimized 200% budget ($)
FSW and client programs (RB)	113,000	0	445,000	393,000	381,000
MSM programs (RB)	40,000	0	401,000	368,000	355,000
NSP(RB)	362,000	0	771,000	681,000	653,000
OST (RB)	315,000	0	342,000	313,000	317,000
FSW and client programs (LB)	0	0	69,000	59,000	63,000
MSM programs (LB)	0	0	86,000	77,000	75,000
NSP (LB)	36,000	20,000	101,000	91,000	87,000
OST (LB)	0	0	265,000	258,000	257,000
PMTCT	96,000	0	0	0	0
HIV testing and counseling	703,000	0	284,000	354,000	808,000
Antiretroviral therapy	2,726,000	2,726,000	2,726,000	5,642,000	7,985,000
BCC and condom programs	1,100,000	0	0	0	0
Cumulative new infections (no.)	38,636	58,291	29,224	24,528	20,041
Cumulative HIV-related deaths (no.)	17,785	21,261	16,136	11,562	8,401

Source: Populated Optima model for Moldova.

Note: Amounts rounded to the nearest US$1,000.

Financial Savings to 2030

Optimizing spending may result in potential savings given that number of new infections likely will decrease and therefore—compared to maintaining current allocations—fewer people will need treatment. Considering projected epidemic and economic trends, in 2050 the country will need to allocate **US$40 million per year to provide necessary services for PLHIV**. Optimization of spending starting from 2015 is projected to require slightly higher health care costs by 2035 (Figure D.4) because, due to higher ART coverage, more PLHIV will survive and continue to require treatment. However, in the long run, optimization will not only increase impact but also reduce future cost. As of 2050, the expected annual savings through optimization alone will account for approximately US$1.5 million and will continue to increase. With additional investment in prevention and treatment now, more new HIV infections could be averted and future cost further reduced.

Figure D.4 Annual costs for providing ART and health care to people living with HIV over 2015–50 for current and optimized spending scenarios

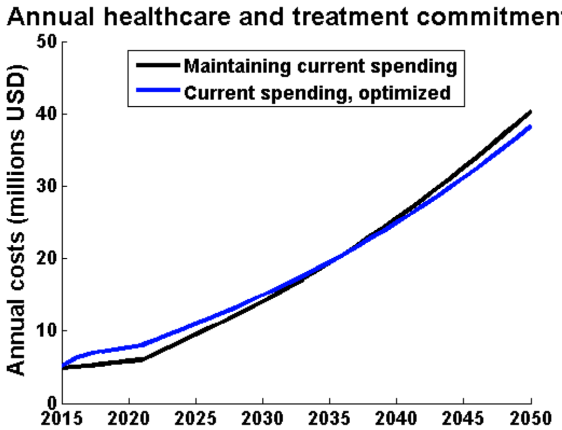
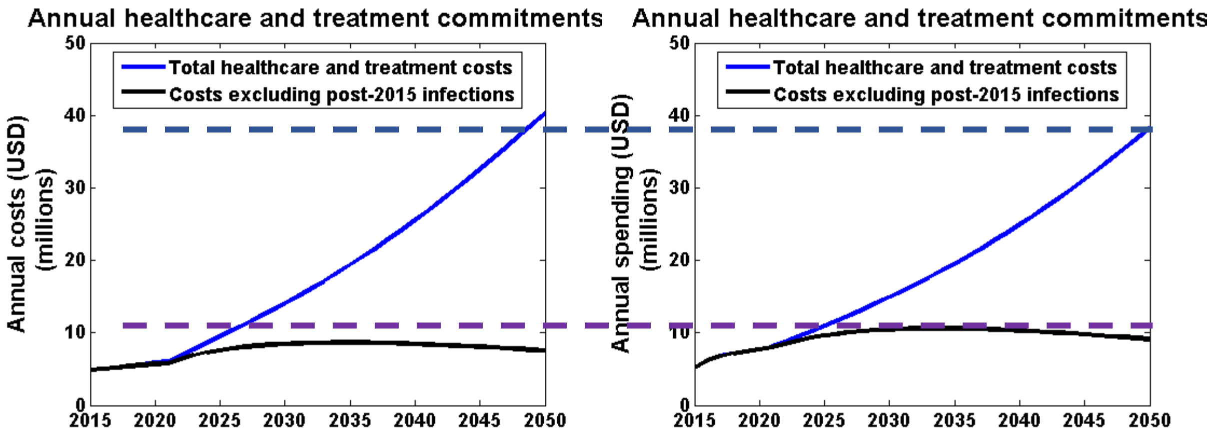


Figure D.5 shows the comparison of future spending for people infected before and after 2015. The trend for PLHIV infected prior to 2015 is similar for current and optimized allocations. In the optimized spending scenario (B), treatment cost for PLHIV infected before 2015 will be higher because reallocation will lead to a decrease in HIV-related mortality, thus more people will survive. However, in the long term, the overall spending would be lower for the optimized allocation given that optimized allocation of HIV funding also would reduce incidence.

Figure D.5 Projected future commitments for (A) current spending allocation and (B) optimized allocation to minimize incidence and deaths, 2015–50

D.5a Current spending allocation **D.5b Optimized allocation**



APPENDIX E. 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 infectionunder	Treatment given to PLHIV to prevent either a first episode of an OI (primary prophylaxis) or the recurrence of infection (secondary

medical(OI prophylaxis)	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.

APPENDIX F. REFERENCES

Anderson, S.-J., P. Cherutich, N. Kilonzo, I. Cremin, D. Fecht, D. Kimanga, M. Harper, R.L. Masha, P.B. Ngongo, W. Maina, M. Dybul, and T.B. Hallett. 2014. "Maximising the Effect of Combination HIV Prevention through Prioritisation of the People and Places in Greatest Need: A Modelling Study." *The Lancet* 384 (July): 249–56.

Craig, A.P., H.-H. Thein, L. Zhang, R.T. Gray, K. Henderson, D. Wilson, M. Gorgens, and D.P. Wilson. 2014. "Spending of HIV Resources in Asia and Eastern Europe: Systematic Review Reveals the Need to Shift Funding Allocations toward Priority Populations." *Journal of the International AIDS Society* 17: 18822.

Eaton, J.W., N.A. Menzies, J. Stover, V. Cambiano, L. Chindelevitch, A. Cori, J.A. Hontelez, S. Humair, C.C. Kerr, D.J. Klein, S. Mishra, K.M. Mitchell, B.E. Nichols, P. Vickerman, R. Bakker, T. Bärnighausen, A. Bershteyn, D.E. Bloom, M.C. Boily, S.T. Chang, T. Cohen, P.J. Dodd, C. Fraser, C. Gopalappa, J. Lundgren, N.K. Martin, E. Mikkelsen, E. Mountain, Q.D. Pham, M. Pickles, A. Phillips, L. Platt, C. Pretorius, H.J. Prudden, J.A. Salomon, D.A. Van de Vijver, S.J. de Vlas, B.G. Wagner, R.G. White, D.P. Wilson, L. Zhang, J. Blandford, G. Meyer-Rath, M. Remme, P. Revill, N. Sangrujee, F. Terris-Prestholt, M. Doherty, N. Shaffer, P.J. Easterbrook, G. Hirnschall, and T.B. Hallett. 2014. "Health Benefits, Costs, and Cost-Effectiveness of Earlier Eligibility for Adult Antiretroviral Therapy and Expanded Treatment Coverage: A Combined Analysis of 12 Mathematical Models." *The Lancet* Global Health 2: e23–e34.

Fraser, N., C. Benedikt, M. Obst, E. Masaki, M. Görgens, R. Stuart, A. Shattock, R. Gray, and D.P. Wilson. 2014. "Sudan's HIV Response: Value for Money in a Low-Level HIV Epidemic. Findings from the HIV Allocative Efficiency Study." World Bank, Washington, DC. http://documents.worldbank.org/curated/en/2014/09/20457933/sudans-hiv-response-value-money-low-level-hiv-epidemic-findings-hiv-allocative-efficiency-study.

Government of the Republic of Moldova. 2013. "The Third Report on Millennium Development Goals." Chisinau.

IMF (International Monetary Fund). 2014. "World Economic Outlook Database" (WEOdata). Washington, DC. https://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx.

INSERM (Institut national de la santé et de la recherche médicale) and UNAIDS (Joint United Nations Program on HIV/AIDS). 2015. "Intervention Packages against HIV and HCV Infections among People Who Inject Drugs in Eastern Europe and Central Asia: A Modeling and Cost-Effectiveness Study. Preliminary Report on Cost-Effectiveness, Belarus." INSERM, Paris and UNAIDS, Geneva. February.

Kerr, C.C., R.M. Stuart, R.T. Gray, A.J. Shattock, N. Fraser, C. Benedikt, M. Haacker, M. Berdnikov, A.M. Mahmood, S.A. Jaber, M. Gorgens, and D.P. Wilson. 2015. Optima: A Model for HIV Epidemic Analysis, Program Prioritization, and Resource Optimization." *JAIDS (Journal of Acquired Immune Deficiency Syndromes)* (March). http://mobile.journals.lww.com/jaids/_layouts/oaks.journals.mobile/articleviewer.aspx?year=2015&issue=07010&article=00017.

Kerr, C.C., T. Smolinski, S. Dura-Bernal, and D.P. Wilson. Under review. "Optimization by Bayesian Adaptive Locally Linear Stochastic Descent." "Nature Scientific Reports." http://scholar.google.com/citations?view_op=view_citation&hl=en&user=TFy7ncUAAAAJ&citation_for_view=TFy7ncUAAAAJ:Ug5p-4gJ2f0C.

OECD (Organisation for Economic Co-operation and Development). 2014. Creditor Reporting System. Paris. https://stats.oecd.org/Index.aspx?DataSetCode=CRS1.

Republic of Tajikistan. 2014. "Modelling an Optimized Investment Approach for Tajikistan: Sustainable Financing of National HIV Responses." By C. Hamelmann, P. Duric, C. Kerr, and D.P. Wilson, Ministry of Health. Dushanbe. http://www.eurasia.undp.org/content/dam/rbec/docs/UNDP20Modelling20Tajikistan_English.pdf.

UNAIDS (Joint United Nations Program on HIV/AIDS). 2014a. AIDSinfo database. Geneva. http://www.unaids.org/en/dataanalysis/datatools/aidsinfo.

_____. 2014b. "Fast-Track: Ending the AIDS Epidemic by 2030." Geneva.

_____. 2014c. "The Gap Report." Geneva.

_____. 2014d. "90-90-90: An Ambitious Treatment Target to Help End the AIDS Epidemic." Geneva.

_____. 2015. "How AIDS Changed Everything: HIV Estimates with Uncertainty Bounds 1990–2014." Geneva

UNGASS (United Nations General Assembly). 2011. Resolution adopted by the General Assembly 65/277. Political Declaration on HIV and AIDS: Intensifying Our Efforts to Eliminate HIV and AIDS. New York.

University of Washington. 2014. 2010 Global Burden of Disease Study. Data Visualizations. IHME (Institute for Health Metrics and Evaluation), Seattle. http://vizhub.healthdata.org/gbd-cause-patterns/; http://www.healthdata.org/results/data-visualizations.

WHO (World Health Organization). 2014. National Health Accounts. http://www.who.int/health-accounts/en/.

Wilson, D.P., B. Donald, A.J. Shattock, D. Wilson, N. Fraser-Hurt. 2015. "The Cost-Effectiveness of Harm Reduction." *International Journal of Drug Policy* 26 (Suppl 1): S5–S11.

World Bank. 2014. World Development Indicators. Washington, DC. http://data.worldbank.org/data-catalog/world-development-indicators.