Optimizing HIV Investments in Armenia

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OPTIMIZING HIV INVESTMENTS IN ARMENIA

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ABBREVIATIONS

AE	allocative efficiency
AIDS	acquired immune deficiency syndrome
ART	antiretroviral therapy
ARV	antiretroviral (drug)
BALLSD	Bayesian adaptive locally linear stochastic descent
BCC	behavior change communication
CD4 cell	T–lymphocyte cell bearing CD4 receptor
CRS	creditor reporting system (OECD)
DALY	disability-adjusted life year
ECA	Europe and Central Asia
FSW	female sex worker
GARPR	Global AIDS Response Progress Report
GBD	global burden of disease
GDP	gross domestic product
Global Fund	The Global Fund to Fight AIDS, Tuberculosis and Malaria
HCV	hepatitis C virus
HDI	Human Development Index
HIV	human immunodeficiency virus
HTC	HIV testing and counselling
IBBS	Integrated bio-behavioral surveillance
IMF	International Monetary Fund
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 (WHO)
NSP	needle and syringe exchange program
OECD	Organisation for Economic Co-operation and Development
OST	opiate substitution therapy
PEPFAR	United States' President's Emergency Plan for AIDS Relief
PLHIV	People living with HIV
PMTCT	prevention of mother-to-child transmission
PWID	people who inject drugs
SDG	Sustainable Development Goal
STI	sexually transmitted infection
TB	tuberculosis
THE	total health expenditure
UC	universal health coverage
UNAIDS	Joint United Nations Program on HIV/AIDS
UNDP	United Nations Development Programme
UNSW	University of New South Wales
USAID	United States Agency for International Development

US$	United States dollar
WEO	World Economic Outlook (IMF)
WHO	World Health Organization
YLL	Years of life lost

KEY MESSAGES

Armenia has a range of key HIV programs in place. The country could strengthen the effectiveness of its HIV response through six measures:

1. **ART** program funding should be increased substantially and considered a top priority for the HIV response.
2. **OST program** funding and coverage should be increased as a high priority.
3. **PWID** and **NSP** (needle and syringe exchange program), **PMTCT** (prevention of mother-to-child transmission), and **prisoner** program funding should be maintained. At the same time it should be explored whether coverage, quality, and targeting can be continuously improved with available funding.
4. **Programs for seasonal migrants** should be rigorously evaluated to assess their effectiveness and ongoing implementation.
5. **HIV testing and counselling program** funding will be used most effectively by making programs specific to key populations.
6. **Additional implementation efficiency analysis is necessary to determine the potential to reduce unit costs** of all programs.

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EXECUTIVE SUMMARY

This report summarizes findings from an allocative efficiency (AE) analysis conducted for the Government of Armenia as part of a Regional initiative on allocative efficiency analysis.

Given its estimated 4,000 people living with HIV (PLHIV) in 2014, Armenia is experiencing a low-level, concentrated HIV epidemic.[1]

According to available data, the epidemic is stabilizing in most key populations including female sex workers (FSW), men who have sex with men (MSM), and people who inject drugs (PWID).

The AE analysis indicates that, using the same US$3.9 million of annual programmatic HIV spending recorded in 2013, Armenia could avert an additional 290 new HIV infections and 288 AIDS-related deaths from 2015 to 2020 if these resources were allocated optimally to minimize both HIV incidence and AIDS-related deaths. These health outcomes could be achieved by reassigning funding in four ways:

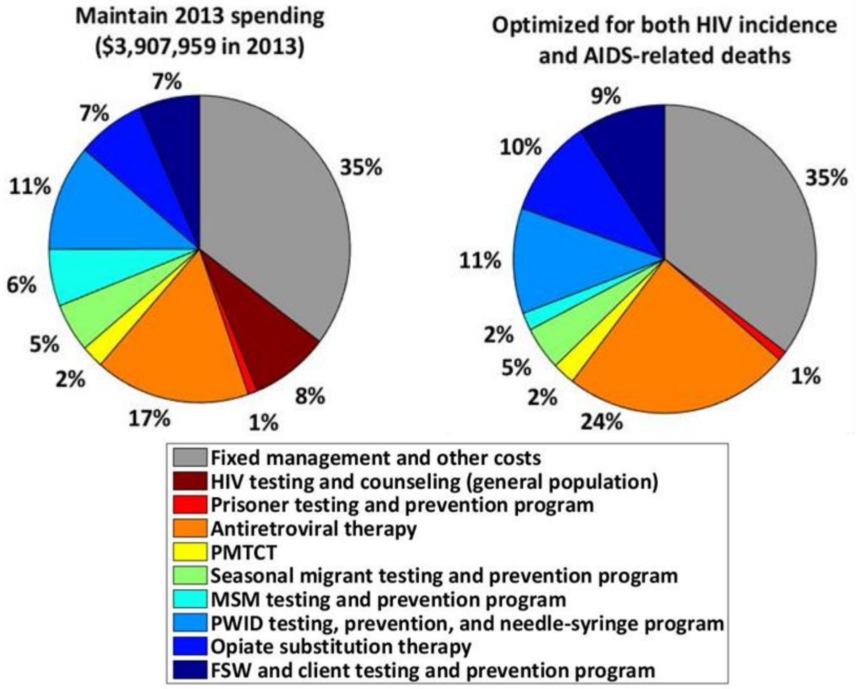
1. The allocation to ART should increase from 17 percent of the total HIV budget (2013) to 24 percent of all HIV funding.
2. The allocation to opiate substitution therapy (OST) should increase from the 7 percent of the HIV budget in 2013 to approximately 10 percent.
3. The FSW and client testing and prevention program also should be scaled up to receive approximately 9 percent instead of 7 percent of the allocation, so that coverage can be increased.
4. The model analysis indicates that HIV testing and counselling in the general population should be defunded.

Cost to achieve national strategy targets

- An investment of US$6 million annually for programs could achieve the national target of a 50 percent reduction in HIV incidence and AIDS-related deaths by 2020. As noted above, ART, OST, and FSW condom and testing programs should be prioritized.
- Should all money necessary to achieve national targets in Armenia be available, this funding could avert an additional 641 new infections and 378 AIDS-related deaths during 2013–20.

1 The lower and upper bounds of the range of HIV estimates were 2,700–5,900 PLHIV (UNAIDS 2015).

Figure 1.1 Optimal allocation of 2013 funding levels to minimize both HIV incidence and AIDS-related deaths by 2020 (%)



Source: Populated Optima model for Armenia.

Conclusions and Recommendations

Ten conclusions and recommendations can be drawn from the AE analysis undertaken in Armenia:

1. The Optima analysis projects a stable epidemic in most population groups until 2020. This projection assumes that the 2013 behaviors and coverage of the programs are maintained. The results suggest that the **past and ongoing efforts have had a substantial impact on the course of the epidemic compared to a scenario with no HIV program spending**. Projections from the model up to 2020 show that the 2013 budget allocations for programs would avert more than 40 percent of the cumulative new HIV infections and 59 percent of AIDS-related deaths compared to a scenario with no spending on HIV programs.
2. Despite the efforts by the Government of Armenia to control the HIV epidemic and the considerable impact that the current budget allocation has, the **optimization analysis suggests that specific budget reallocations could further improve health impacts of the HIV response** with the currently available (2013) resources.
3. The analysis suggests that the **ART program should be prioritized** and that the ART budget should increase by another 40 percent over the current (2013) funding of US$650,000 allocated for ART to increase investment in ART to over US$900,000 per year on average.
4. **FSW programs** will continue being cost-effective interventions because, despite relatively low HIV prevalence and population size of female sex workers, their large number of interactions with the much larger client population can cause a substantial number of new HIV infections. The funding for these programs **should be increased moderately to achieve high levels of program coverage**.
5. Programs targeting the general population should be defunded. The funding **should be reallocated to the high-impact programs including ART and prevention for key populations.**

6. Analysis results suggest that current allocations for **OST should be increased** by approximately one-third. **Prevention programs for PWID** including needle and syringe exchange programs, HIV testing counselling (HTC) and condoms for PWID **should continue to receive 11 percent of HIV funding**—the second largest allocation after ART. In addition, whether coverage, quality, and targeting can be continuously improved with 2013 funding levels should be explored.
7. **Programs for seasonal migrant laborers** including testing and other prevention services were introduced in response to the increasing contribution of seasonal migrant laborers to new infections. These programs are new, and their efficacy has yet to be established. Thus, it is recommended to implement a pilot program and **rigorously evaluate the outcomes** including uptake of HTC and other HIV services.
8. The **MSM epidemic should be monitored carefully**, particularly because of the rapidly growing HIV epidemic among MSM in neighboring Georgia. MSM programs should be sustained with a focus on urban sites that have larger MSM populations and continued epidemiological surveillance.
9. This analysis did not focus on identifying technical efficiencies or reviewing unit costs; therefore, no specific recommendations can be made regarding them. Given limited resources, **it is worth conducting additional technical efficiency analyses that focus on the programs that absorb the largest proportions of funding:** ART, OST, PWID/NSP, seasonal migrant HIV services, and management.

The Armenian government's 2012 spending on health was 7.9 percent of all government expenditure, which was below the global average of 11.7 percent. By **increasing overall government spending on health**, Armenia also could increase domestic HIV financing and thereby contribute to covering resource gaps in its HIV response.

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1. INTRODUCTION

1.1 Necessity for allocative efficiency

Globally, current HIV programs are faced with the necessities of scaling up prevention and providing treatment to a larger number of people living with HIV (PLHIV) more 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, Kyrgyz Republic, Moldova, Ukraine, and a number of countries outside the ECA Region carried out allocative efficiency (AE) analyses.[2] This report summarizes the results of the analysis for policy makers, program leaders, and technical experts in Armenia.

The concept of allocative efficiency refers to maximizing health outcomes with the least costly mix of health interventions.[3] 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*

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

3 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).

the highest impact? Not only is this concept critical for maximizing current and 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 were distributed optimally or were used in the most efficient ways.

1.2 Objectives of the analysis

In response to the key strategic information needs in Armenia's HIV response, the following analyses were conducted:

1. A program optimization analysis to determine the optimal combination of programs to minimize HIV incidence and AIDS-related deaths over 2015−20. The main question in this analysis was: **How are resources best allocated to different HIV programs to minimize cumulative HIV incidence and cumulative AIDS-related deaths over 2015–20?**
2. The second analysis was based on the first and aimed to identify resource requirements of the HIV response under a rights-based approach and for existing country commitments. The main purpose of the second analysis was to determine **the minimum funding requirement to achieve national strategy targets**. This analysis also established the gap in the funding required to achieve these targets. Two questions were addressed: **What is the minimal spending required to fully achieve Armenia's National Strategy impact targets? How should such funds be allocated?**

2. ARMENIA'S HEALTH AND HIV FINANCING CONTEXT

Between 1990 and 2012, Armenia's human development index (HDI) rose from 0.628 to 0.729—positioning the country at 87 of 187 countries and territories. Table 2.1 reviews Armenia's progress on the HDI indicators. In 22 years (1990–2012), Armenia's life expectancy at birth increased by 6.5 years and mean years of schooling by 0.7 years. In 2013 Armenia's GDP per capita was US$3,505. Armenia's economy rebounded after the 2009 economic crisis from 2.2 percent GDP growth in 2010 to 7.2 percent growth in 2012, but slowed to 3.5 percent in 2013.

Table 2.1 Armenia: Human development indicators, 1990–2012

Year	Life expectancy at birth (years)	Expected years of schooling	Mean years of schooling	GDP per capita (current US$)	HDI value
1990	67.9	9.9	10.1	636.7	0.628
1995	68.8	9.9	10.4	455.6	0.601
2000	71.2	11.0	10.8	621.4	0.648
2005	73.2	11.0	10.8	1,625.4	0.695
2010	74.1	12.2	10.8	3,124.8	0.722
2011	74.2	12.2	10.8	3,421.7	0.726
2012	74.4	12.2	10.8	3,354.0	0.729

Source: UNDP 2013; World Bank 2014.
Note: HDI = human development index.

Health care in Armenia is financed from domestic, private, and external sources. In 1998 the government adopted the *Basic Benefit Package* (BBP), comprising a basket of public-funded services, the list of services, and the population groups entitled to them. Since 2000, BBP also has covered primary health care (PHC); child healthcare; obstetrical and gynecological services; health care of socially vulnerable groups; control and emergency care of communicable and noncommunicable diseases; specified specialized treatments such as for tuberculosis (TB), sexually transmitted infections (STIs), blood diseases, and drug abuse; as well as psychiatry, narcology, and oncohematology therapy. Overall health expenditure trends are summarized in Table 2.2.

Table 2.2 Healthcare expenditure in Armenia, 2000–13

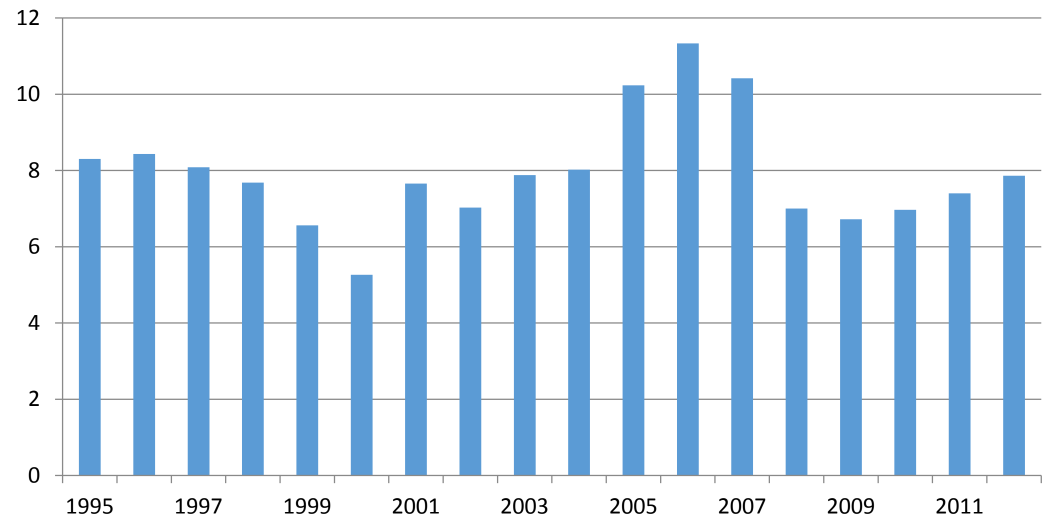
Indicator		2000	2005	2010	2011	2012	2013
Total health spending							
Gross domestic product	Current US$ million	1,910	4,943	9,293	10,151	9,963	10,446
Total expenditure on health	Current US$ million	119	260	424	377	447	472
Total health expenditure (THE) as % GDP	%	6	5	5	4	4	5
Total expenditure on health/capita	Per capita (US$)	39	86	143	127	150	159
Government health spending							
General government expenditure	Current US$ million	413	920	2,564	2,660	2,377	2,510
General government expenditure on health	Current US$ million	22	94	179	197	187	197
GGHE as % general government expenditure	%	5	10	7	7	8	8
General government expenditure on health as % THE	%	18	36	42	52	42	42
Private health spending							
Private expenditure on health	Current US$ million	98	165	245	180	260	275
Private expenditure on health as % THE	%	82	64	58	48	58	58
Out-of-pocket expenditure as % THE	%	77	62	56	47	55	55
Out-of-pocket expenditure as % private health expenditure	%	95	97	97	98	94	94
External funding							
Rest of the world (ROW) funds/ External resources	Current US$ million	10	34	32	30	29	31
External resources on health as % THE	%	9	13	8	8	6	6

Source: WHO Global Health Expenditure Database, http://apps.who.int/nha/database/ViewData/Indicators/en.

From 1995 to 2012, the Armenian government's health expenditures fluctuated substantially. Health accounted for 5.3 percent of total government expenditure in 2000 and 11.3 percent in 2006 (Figure 2.1). In 2012, health accounted for only 7.9 percent of government expenditure—considerably lower than the global average of 11.7 percent.

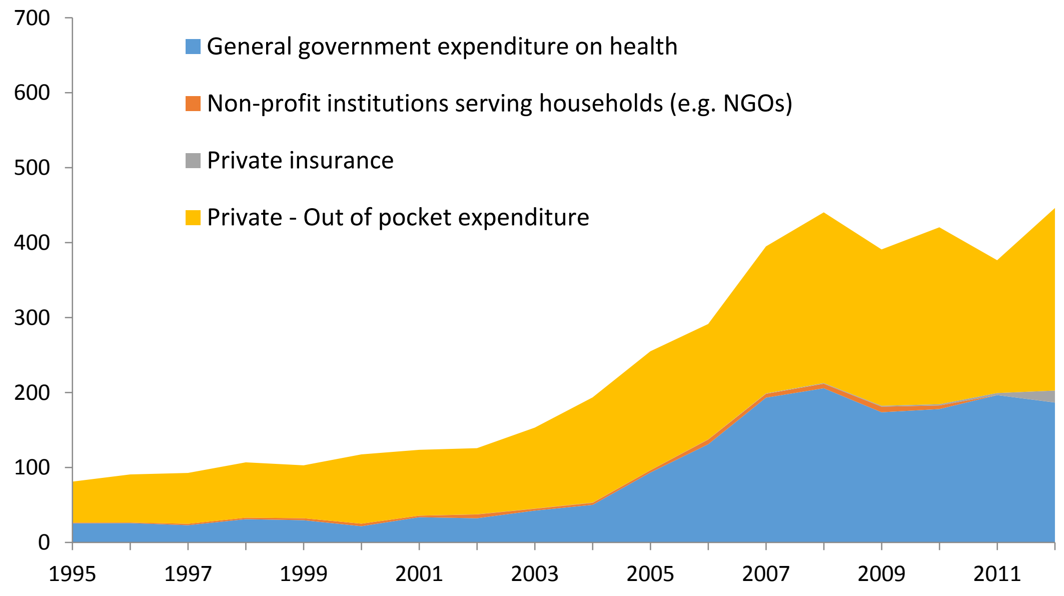
Domestic financial sources include state budget allocations, direct contributions of citizens (or households (out-of-pocket expenditures), copayments, and health insurance. Public expenditure on health accounts for 1.7 percent of GDP. Private spending accounts for nearly 50 percent of total health expenditures, or 1.8 percent of GDP (Figure 2.2).

Figure 2.1 General Government Health Expenditure (GGHE) as share of general government expenditure in Armenia, 1995–2012 (%)



Source: WHO 2014.

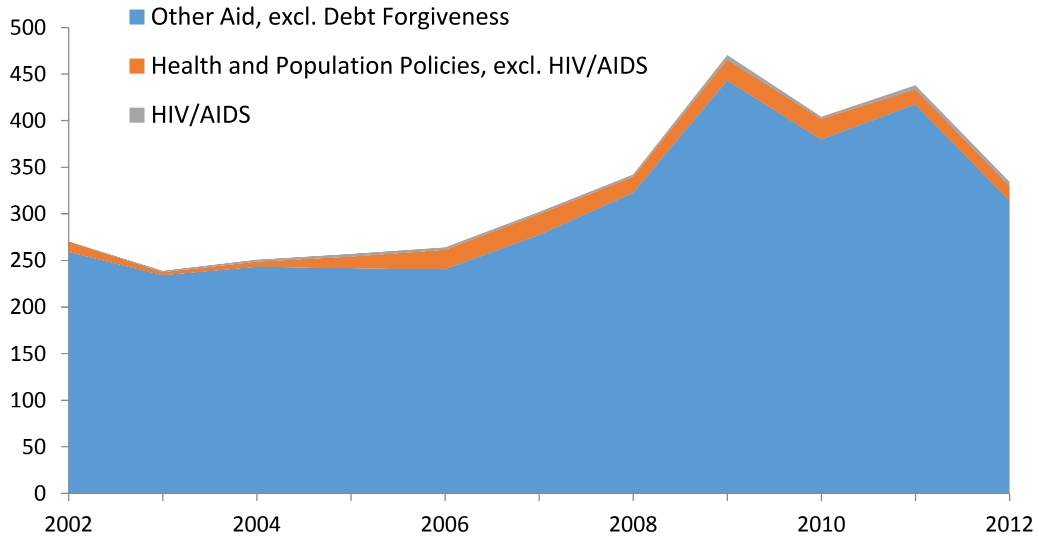
Figure 2.2 Health spending by source of financing in Armenia, 1995–2012 (US$ million)



Source: WHO 2014.

Between 2002 and 2009, external assistance to Armenia increased, when it peaked at approximately US$443 million (Figure 2.3). It then declined to US$314 million in 2012. Health, population, and HIV/AIDS accounted for a relatively small proportion of external assistance, remaining just below 7.0 percent of total external aid in 2012. That year, US$15.7 million was allocated to health and population issues and US$4.6 million to HIV/AIDS.

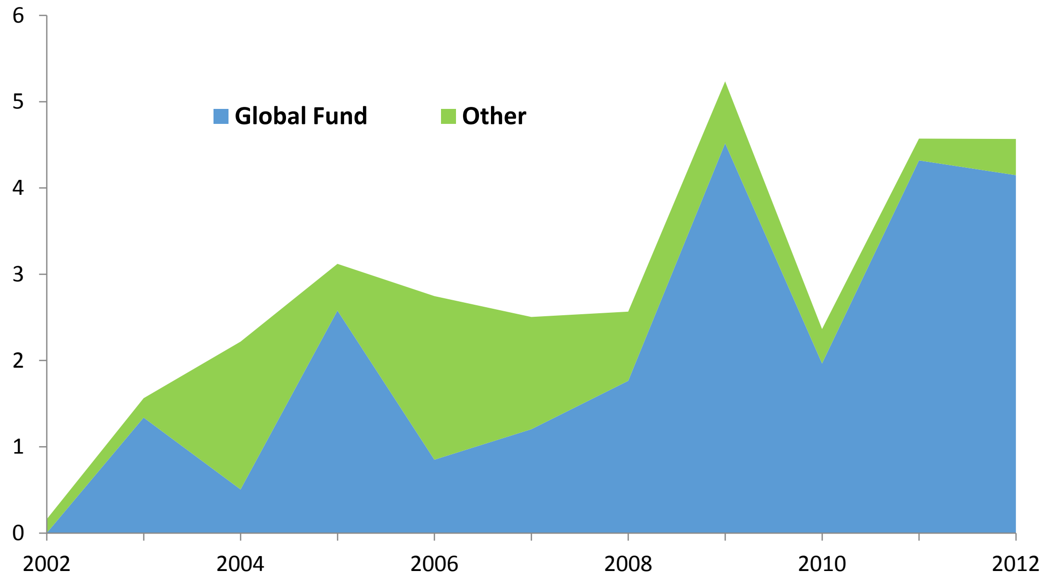
Figure 2.3 Aid disbursements to Armenia, 2002–12 (US$ million)



Source: OECD, CRS, 2014.

External support to the HIV response has been increasing since 2002 with the Global Fund, U.S. Government, and Russian government being the major supporters (Figure 2.4). Since 2008, the majority of external support has come through the Global Fund.

Figure 2.4 HIV/AIDS-related aid disbursements to Armenia by donor, 2002–12 (US$ million)



Source: OECD, CRS, 2014.

The national HIV response strategies are consolidated in the National Program on the Response to the HIV Epidemic in the Republic of Armenia for 2013–2016. The activities implemented within the framework are funded by the Global Fund to Fight AIDS, Tuberculosis and Malaria; allocations from the State budget; and financial support from other donors. According to the available data, in 2013 total AIDS spending in Armenia was AMD 2.05 billion (US$5.0 million). The sum of allocations from the State budget made up 21.4 percent of the total AIDS spending (Table 2.3). Moreover, 78.5 percent of Armenia's HIV response was externally funded—a considerably larger share of external funding compared to other countries with a similar HIV epidemic. Although over 50 percent of all of Armenia's healthcare costs were financed privately, the contribution of private sources to HIV expenditure was minimal.

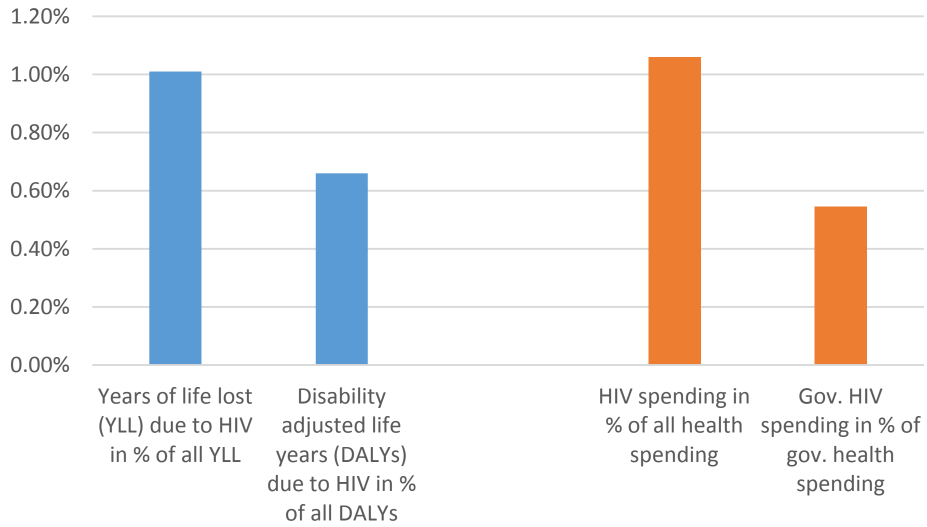
Table 2.3 HIV spending in Armenia by source, 2013

	2013 (US$1 = 409.63 AMD)		
	AMD	**US$**	**%**
State budget	439,454,728	1,072,809	21.4
GFATM	1,172,066,564	2,861,281	57.2
UN agencies	9,395,955	22,938	0.5
Other international	427,265,901	1,043,053	20.8
Russian Federation Government	*301,509,206*	*736,053*	*14.7*
Private sector	2,268,000	5,537	0.1
Total	**2,050,451,148**	**5,005,618**	**100.0**

Source: UNAIDS 2013.

The State's approximately US$1.1 million spent on HIV in 2013 represented 0.5 percent of its total spending on health (US$197 million) (Figure 2.5). In other words, the share of government spending on HIV was below the overall share of HIV spending within total health expenditure (1.1 percent). Considering that HIV accounted for 1.0 percent of years of life lost (YLL) and 0.7 percent of disability-adjusted life years (DALYs) in Armenia, the government's HIV spending also fell below HIV's share of the total disease burden.

Figure 2.5 Levels of HIV disease burden compared to levels of HIV spending, 2010-13 (%)



Source: WHO 2014; UNAIDS 2013; University of Washington 2014.

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

Chapter 3 outlines the main steps taken and the 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 would impact 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 modeling 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 modeling 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 modeling 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	Parametrization in Optima model	Description/Assumptions
Populations defined in model	Female sex workers	Females, aged 15–49
	Clients of sex workers	Males, aged 15–49
	Men who have sex with men	Males, aged 15–49
	People who inject drugs	Males, aged 15–49
	Children	Males and females, aged 0–14
	Males, 15–49	Males, aged 15–49
	Females, 15–49	Females, aged 15–49
	Older men	Males, aged 50+
	Older females	Females, aged 50+
	Prisoners	Males aged, 15–49
	Seasonal migrant laborers	Males, aged 15–49
Expenditure areas defined in model and included in optimization analysis	Prevention programs for female sex workers	Condom distribution, HIV testing and counselling, community outreach
	Prevention programs for MSM	Condom distribution, HIV testing and counselling, community outreach
	Needle and syringe programs	Needle and syringe distribution
	Other prevention for PWID	Condom distribution, HIV testing and counselling, community outreach
	Opiate substitution therapy	Provision of medication and related counselling
	HIV testing and counselling	HIV test kits and pre- and post-testing counselling
	Antiretroviral therapy	Antiretroviral drugs, related laboratory monitoring and clinic visits
	Prevention of mother-to-child transmission	HIV testing of pregnant women, counselling, and provision of antiretroviral prophylaxis for women living with HIV*
	Seasonal migrant laborer testing and prevention program	Condom distribution, HIV testing and counselling, community outreach
	Prisoners testing and prevention program	Condom distribution, HIV testing and counselling, community outreach
Expenditure areas not included in optimization (effectiveness in reducing HIV incidence, morbidity/mortality not known or indirect effects)	Management and other costs	Management, coordination, advocacy and support for PLHIV, infrastructure, monitoring, evaluation, surveillance, research, enabling environment, human resources (details below)
Time frames	2014 (baseline)	Available data from 2000–14 were used. Projections started with 2015.
	2015–20 period for optimization	Optimizations were performed up to 2020
Baseline scenario funding	US$5,005,618	2013 spending as per Optima spreadsheet prepared based on GARPR, financial report tables

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

Populations include ***key populations,*** which are defined around the dominant factor influencing HIV acquisition; and ***general populations*****,** which are disaggregated by age and sex. **Programs** were divided into two categories. **Direct programs** have a direct effect on HIV incidence or deaths so could be included in the mathematical optimization analysis. **Indirect programs** are cross-cutting expenses or have indirect or unclear effects on health outcomes so were not included in the mathematical optimization. Within direct programs some service packages target specific key populations (FSW, MSM, and PWID), while others (HTC, ART, PMTCT) cut across all populations including key populations.

Costs per person reached, which were used in this analysis, are presented in Table 3.2. These costs are not strictly comparable among countries, particularly for prevention programs, whose packages differ. In other words, a higher unit cost may not necessarily mean lower technical efficiency but also may mean a more comprehensive package. Costs in Armenia are within the range of costs in other countries, except for PWID-NSP programs, whose costs in Armenia appear higher. Additional analysis would be required to determine in which areas technical efficiencies could be realized.

Table 3.2 Costs per person reached established in the analysis (US$)

	Armenia	Regional comparison (6 countries including Armenia)			
Cost per person reached	**2013**	**Lowest**	**Highest**	**Average**	**Median**
FSW programs	107.05	41.66	166.24	102.94	105.35
MSM programs	94.71	23.67	449.13	159.45	71.25
PWID-NSP programs	129.27	40.90	129.25	109.73	84.11
OST program	940.45	431.41	1,645.24	747.36	790.23
PMTCT program	1,928.24	738.08	8,905.27	4,616.80	4,267.59
ART program	987.39	576.48	2,278.52	1,203.26	1,127.29
Seasonal migrant laborer program	**102.61**	–	–	–	–

Source: Optima data entry spreadsheet based on inputs from GARPR and program reports.
Note: Table 3.2 shows how costs were categorized by countries for this analysis. It is not based on detailed matching of classification of inputs, but on how countries classified expenses using the detailed available guidance for NASA and GARPR reports. Although this guidance is detailed and specific, differences cannot be ruled out, particularly for cross-cutting costs such as HR. Furthermore, even if costs are classified consistently, the comprehensiveness of service packages may differ.

3.3 Limitations of analysis

As with any modeling analysis, it is important to understand the key assumptions and the related limitations:

- For this analysis, standard classification of cost data in line with National AIDS Spending Assessments (NASA) was used. However, program packages differ among countries, limiting the comparability of findings.
- The analysis used past ratios of expenditure to coverage as a basis for determining program cost rather than unit costs from a costing of future programs. This approach of using past cost and results has a number of advantages over using projected costs from plans and budgets, which ultimately are predictions of future cost. However, the approach also has the disadvantage that there may be future increases or decreases in cost in relation to new approaches, implementation arrangements, or technologies.
- The modeling approach used to calculate relative cost-effectiveness among programs includes assumptions concerning the impact of increases or decreases in funding for programs. These assumptions are based on unit costs and observed ecological relationships between outcomes of program coverage or risk behavior and the amount of

money spent on programs in the past. It also is assumed that increases in spending would cause some saturation in the possible effects 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 global systematic literature review,[4] 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. As they still 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 are complex to consider (such as non-health benefits of OST, effects of needle exchange on hepatitis, and effects of condoms on contraception and sexually transmitted infections or STIs). 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 interaction among the interventions and their non-HIV benefits, this approach was applied for OST. Along the same lines, the model does not seek to quantify human rights, stigma and discrimination, or ethical, legal, or psychosocial implications; but acknowledges that these are important aspects to be considered.
- Different 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 among different sources including data from clinical records, surveillance, and research.

There were some country-specific limitations in performing the allocative efficiency analysis in Armenia.

- As in most concentrated HIV epidemics, Armenia's had data gaps, particularly regarding the general population. As in other models, estimates of HIV prevalence in the general population were derived from data in pregnant women as the proxy. Some of the available data also had limitations of nonrandom sampling, which applied to data from both integrated bio-behavioral surveillance (IBBS) and service delivery from HTC sites.
- Epidemiological data were scarce for some population groups such as seasonal migrant laborers and clients of female sex workers. Given the increasing role of seasonal migrant laborers in the epidemic, programs for them potentially are important. However, the information on the effectiveness and level of uptake of seasonal migrant laborer programs is limited.

[4] See the full literature review at www.optimamodel.com.

4. RESULTS AND THEIR INTERPRETATIONS

This chapter presents the findings of the analyses. It moves from the epidemic analysis to the optimization analysis and then to the related cost-effectiveness analysis.

4.1 What is the status of the HIV epidemic in Armenia?

A summary of key national data on the HIV epidemic appears in Table 4.1. It illustrates the rapid growth of new diagnoses and deaths from 2000 to 2010, the continued growth in absolute numbers, and the slowing growth rate from 2010 to 2013. HIV prevalence remains highest among PWID and MSM.

UNAIDS estimates for 2014 suggested that 4,000 persons living with HIV (PLHIV) were living in Armenia and that the estimated HIV prevalence among people aged 15–49 years was 0.2 percent. In combination with available prevalence data for key populations, these estimates indicate that Armenia is experiencing a concentrated epidemic. Between 1988 and 2014, 1,953 people in the country were diagnosed with HIV. Of them, 1,350, or 69 percent of diagnosed PLHIV, were males; 603, or 31 percent, were females; and 38, or 2 percent, were children.

HIV diagnoses were registered in all country administrative divisions. Since the onset of the epidemic in 1988, 667 HIV new diagnoses were reported for Yerevan, or 34.2 percent of all HIV registered diagnoses for Armenia during that period.

The increased number of registered HIV diagnoses in recent years is associated with scaling up laboratory diagnostic capacities, increasing accessibility of HTC due to improved HTC systems, and increasing the level of HIV-related knowledge among health care providers. The efficiency of the HIV surveillance system also has been improved. In addition, Armenian citizens with HIV diagnoses and clinical symptoms have been returning to Armenia from other Commonwealth of Independent States (CIS) countries (more than 90 percent of whom have come from Russia, the majority being male seasonal migrant laborers).

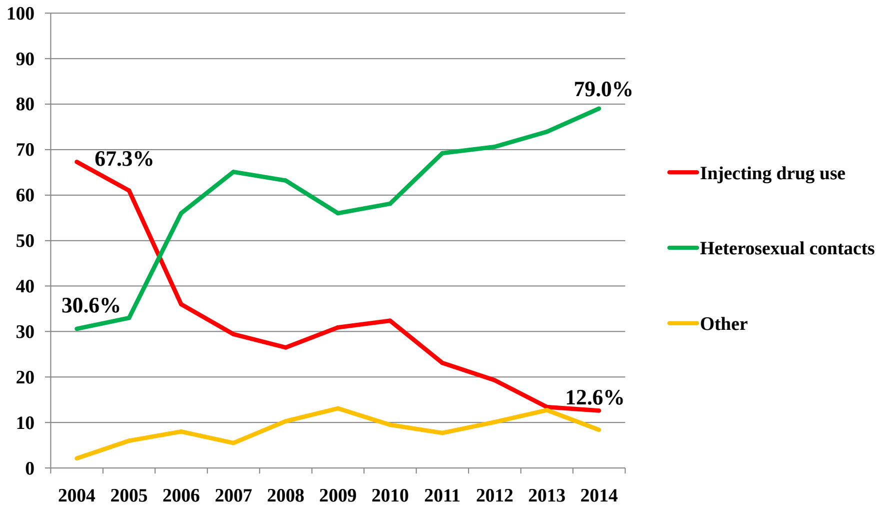
The main self-reported modes of HIV transmission in Armenia are heterosexual transmission (63 percent) and injecting drug use (28 percent). There also are registered cases of HIV transmission through homosexual practices, mother-to-child HIV transmission, and blood transfusions. Almost all the individuals infected via injecting drug use were men. Almost all HIV-positive women (97 percent) report having been infected through sexual contact.

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

	2000	2005	2010	2011	2012	2013	Source
HIV diagnoses							
Cumulative number of people diagnosed with HIV, total	140	363	971	1,153	1,381	1,619	National AIDS Center database
Cumulative registered number of people diagnosed with HIV and alive, total	125	286	740	888	1,076	1,262	
New diagnoses							
Number of people newly diagnosed with HIV, total	29	75	148	182	228	238	National AIDS Center database
Number of people newly diagnosed with HIV (ages 15+)	29	73	144	180	224	233	
Number of people newly diagnosed with HIV (ages 0–14)	0	2	4	2	4	5	
Number of people newly diagnosed with HIV, females	6	15	51	67	70	77	
Number of people newly diagnosed with HIV, males	23	60	97	115	158	161	
Registered HIV related deaths							
Annual registered number of deaths due to AIDS, total	3	10	23	25	37	42	National AIDS Center database
Cumulative registered number of deaths due to AIDS, total	11	46	175	200	237	279	
HIV prevalence among key population (2014)							
HIV prevalence among sex workers (%)	–	0.4	1.2	–	1.3	0.4	IBBS (2014 data included in 2013 column)
HIV prevalence among MSM (%)	–	–	2.3	–	2.7	2.1	
HIV prevalence among PWID (%)	14.0	9.3	10.7	–	6.3	6.3	
HIV prevalence among prison inmates (%)	–	–	1.5	1.1	1.3	1.1	
Service coverage and utilization							
Number of people receiving ART	0	28	253	330	452	579	National AIDS Center database
Number of syringes distributed per estimated PWID	0	0	0	0	0	0	
Estimated number of PWID receiving OST (%)	0.0	0.0	0.0	148.0	215.0	301.0	
Self-reported modes of HIV transmission (% of newly diagnosed with HIV)							
Heterosexual HIV transmission	31.0	33.0	58.1	69.2	70.6	73.9	National AIDS Center database
HIV transmission through IDU	62.1	61.0	32.4	23.1	19.3	13.4	
HIV transmission through unsafe blood or blood products	3.4	0.0	0.7	0.0	0.4	0.0	
Vertical HIV transmission	0.0	3.0	2.0	1.1	1.3	2.1	

Analysis of the HIV diagnoses registered in Armenia during 2004–14 reveals that, in recent years, the percentage ratio of 2 of the main modes of HIV transmission has shifted. The proportion of (self-reported) transmission through injecting drug use dropped 5-fold––from approximately 67 percent to 13 percent. In contrast, the proportion of cases infected through heterosexual contact more than doubled from approximately 31 percent to 79 percent (Figure 4.1).

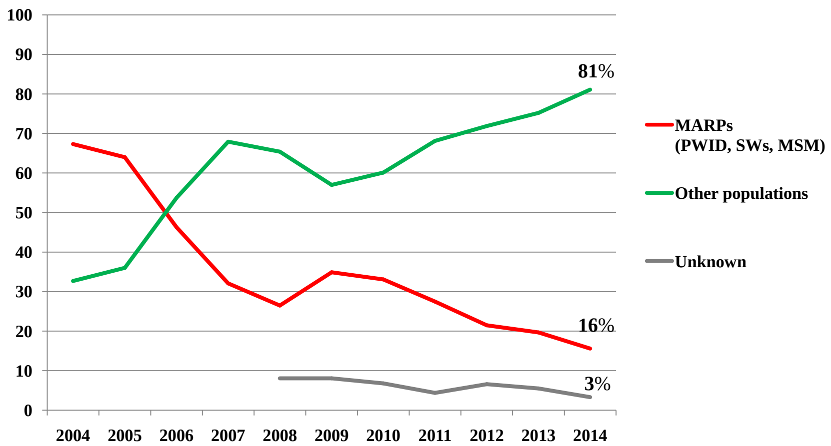
Figure 4.1 Shift in 2 of the main self-reported modes of HIV transmission, 2004–14 (%)



Source: Armenia National AIDS Center data 2015.

According to self-reporting, heterosexual contact has become the primary mode of HIV transmission. During the same decade, the majority of new diagnoses (81 percent) were recorded among seasonal migrant laborers and their partners, the partners of the above-mentioned risk populations, and those practicing unsafe sexual behavior (Figure 4.2). Data limitations include a possibility of desirability bias in self-reported data leading to underreporting of risk behaviors, particularly among MSM and PWID.

Figure 4.2 Distribution of the registered HIV cases by population group, 2004–14 (%)



Source: National AIDS Center 2015.

Seasonal migrant laborers have emerged as a subpopulation who contribute substantially to Armenia's HIV epidemic. Recent data on new HIV diagnoses show that more than 50 percent of the PLHIV registered within the last 4 years probably were infected outside Armenia. Fifty-nine percent of the new HIV diagnoses registered during 2012–14 were infected abroad, with heterosexual transmission reported as the most common cause. Fourteen percent of registered cases were sexual partners of seasonal migrant laborers. Thus, nearly 75 percent of cases newly registered during 2012–14 were associated with migration.

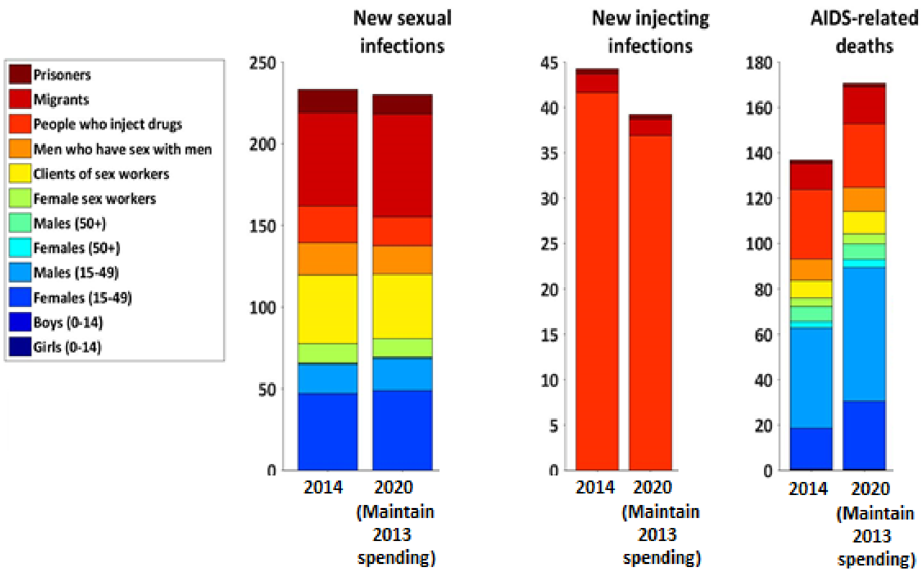
Assuming that current conditions (behaviors and program coverage) remain stable, the six main findings of the Optima epidemic modeling analysis for Armenia are:

1. Armenia is experiencing a **low-level concentrated HIV epidemic**. The number of PLHIV is projected to remain relatively stable until 2020 if current (2013) spending is maintained (Figure 4.10.)

2. An estimated **300 people will become infected, predominantly through sexual transmission and drug injections** and **150 HIV-related deaths will occur in** 2020 according to model projections (Figure 4.3).
3. The epidemic in most population groups is stabilizing. For instance, the model suggests that **HIV prevalence in FSW will stabilize slightly above 1 percent.**
4. HIV **prevalence among PWID and prisoners is projected to decline**.
5. In contrast, a slight **increase in HIV prevalence in** coming years is projected among **seasonal migrant laborers**.
6. A slight increase in HIV prevalence also is projected in **males in the general population and MSM**.

The trends in HIV prevalence in all subpopulations are presented in appendix B.

Figure 4.3 Armenia: New infections and deaths if 2013 spending is maintained, 2014 and 2020



Source: Populated Optima model for Armenia.

4.2 Optimized allocations to minimize HIV incidence and AIDS-related deaths

Optimization analyses were carried out for different levels of funding and different policy questions in line with the objectives of the analyses (section 1.2). Section 4.2 presents the analysis to determine optimal allocations for minimizing both new HIV infections and AIDS-related deaths, which makes this analysis particularly policy relevant. As explained in chapter 3, all management costs and costs for related health services were kept stable and were not included in the mathematical optimization.

4.2.1. Optimized allocations with stable HIV funding at 2013 levels of spending

Figure 4.4 and Figure 4.5 summarize the main outcomes of the optimal allocation analysis. The 5 main findings are:

a. With the same US$3.9 million of programmatic spending as in 2013, Armenia could avert an additional 300 new infections and 300 AIDS-related deaths during 2015–20 if these resources were allocated optimally for both health outcomes. Optimal allocation would correspond to a 17 percent deeper reduction in new infections and 29 percent deeper reduction in cumulative deaths compared to current spending allocations.

b. These health outcomes could be achieved by prioritizing resource allocation to 3 programs (Figure 4.4):

i ART funding should be increased to 24 percent of all HIV funding from 17 percent in 2013.

ii OST funding should be increased to 10 percent of the total HIV budget from 7 percent in 2013.

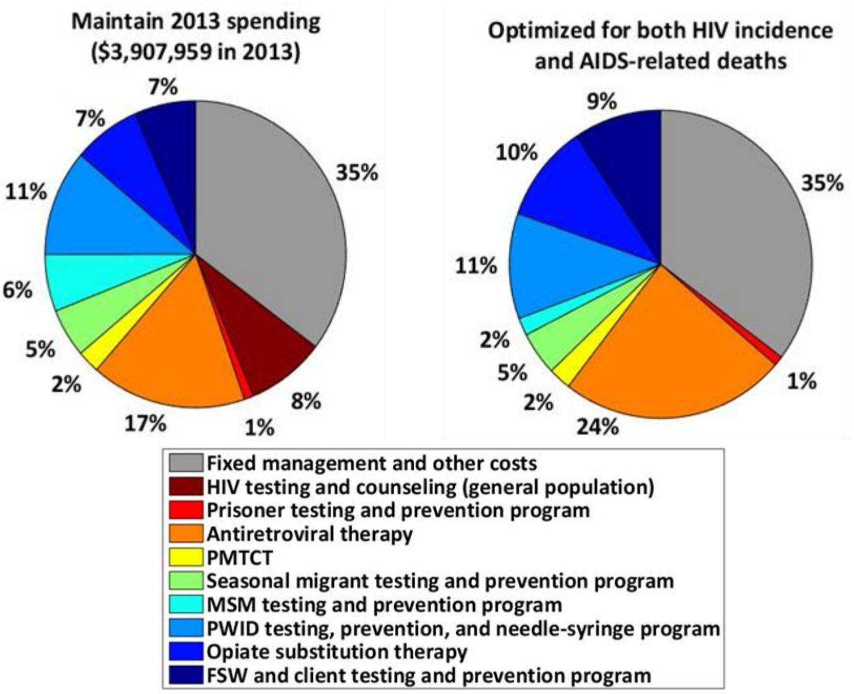
iii The FSW and client testing and prevention program should be allocated 9 percent of the total HIV budget instead of 7 percent as in 2013.

c. The model indicates that HIV testing and counselling in the general population should be defunded.

d. Based on the available inputs, the model suggested that the budget allocated to MSM programs should be reduced to 2 percent of the total HIV budget (Figure 4.4). As mentioned above, this finding likely would change with reduced unit cost of MSM programs. In addition, given the increasing epidemic among MSM in neighboring Georgia, the HIV epidemic among MSM could grow faster than projected here because the model does not take into account international interactions. If HIV prevalence among MSM or the number of MSM does increase, MSM programs likely would have a larger epidemiologic effect and funding may need to be increased rather than decreased.5

e. The cost per new infection and AIDS-related death averted would be US$12,700 and US$21,000, respectively.

Figure 4.4 Armenia: Optimal allocation of 2013 funding levels to minimize both HIV incidence and AIDS-related deaths by 2020 (%)



Source: Populated Optima model for Armenia.
Note: Figure 4.4 is the same as **Error! Reference source not found.**, which was included in the Executive Summary using a different layout and which is reproduced here for the convenience of the reader.

4.2.2. Optimized allocations for different levels of available funding

Optimization analysis also was carried out assuming different funding levels (Figure 4.5). The two subfigures show the optimal allocation of resources to specific programs, and the resulting impacts if Armenia's HIV response were to receive more or less funding than the US$3.9

5 Possible effects of the growing HIV epidemic among MSM in Georgia on the MSM epidemic in Armenia were not reflected in the epidemiological projections because of limited quantitative information on interactions.

million allocated in 2013. Should more funding be available, additional reductions in new infections and deaths could be obtained, but the impact would be rather small.

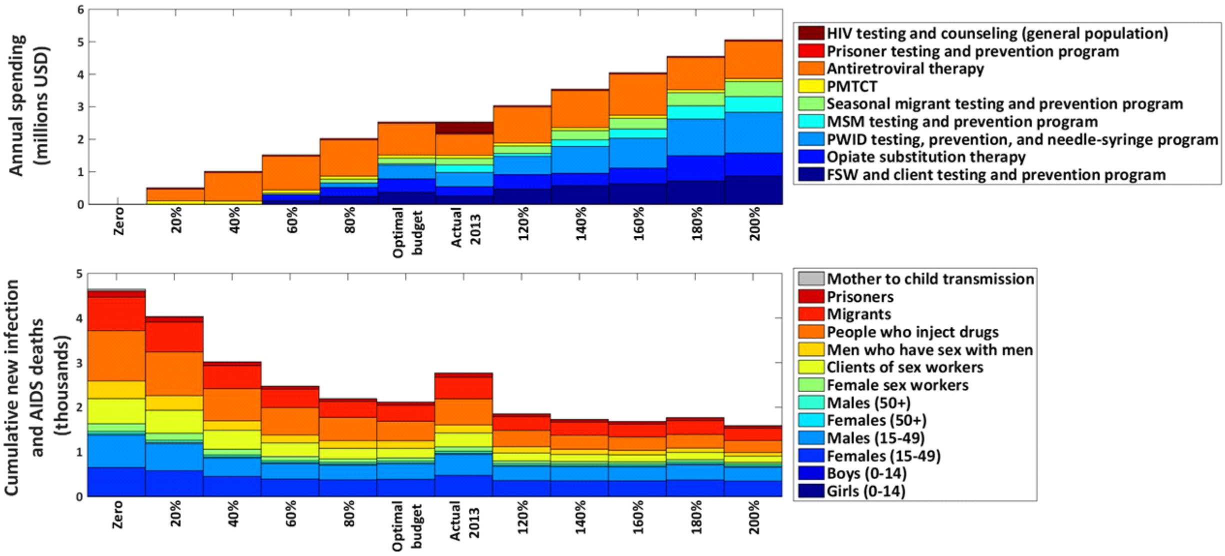
When comparing optimal allocations for different funding levels, three observations can be made:

a. For any investment between 100 percent and 200 percent of the 2013 spending, optimization suggests that investment should be focused on 4 programs: ART, PWID, OST, and prevention among FSW.

b. If only 60 percent of 2013 spending were available, optimization suggests that investment should be focused primarily on ART and PWID programs. The results also highlight a considerable increase in new HIV infections or AIDS-related deaths if the budget were reduced by more than 30 percent despite an optimal allocation of the resources.

c. General population programs are not part of any of the optimal allocations.

Figure 4.5 Spending allocations for varying budgets to minimize both HIV incidence and AIDS-related deaths by 2020 (%)



Source: Populated Optima model for Armenia.

4.3 Cost to achieve targets

4.3.1. Cost to achieve national strategy targets

From 2000–05, Armenia's HIV epidemic was mostly concentrated among PWID, but, after 2005, new infections have been growing in other populations and overall. In this context, reversing the epidemic and achieving national targets by 2020 is projected to require an increase in annual spending. Using Optima, the team calculated that the minimal spending required to achieve Armenia's moderate objectives would be twice as large as the current (2013) spending (Figure 4.6). To achieve the moderate objectives efficiently, scale-up, especially of ART but also of OST and of the FSW and client testing and prevention program, is required (Figure 4.6).

Optimizing allocations to meet national targets is projected to achieve 7 results:

a. Approximately US$6 million annually for programs would achieve the national targets of a 50 percent reduction in HIV incidence and AIDS-related deaths.

b. Incidence would be reduced to fewer than 200 new infections per year by 2020 (Figure 4.7).

c. HIV-related deaths would be reduced to fewer than 100 per year by 2020 (Figure 4.7).

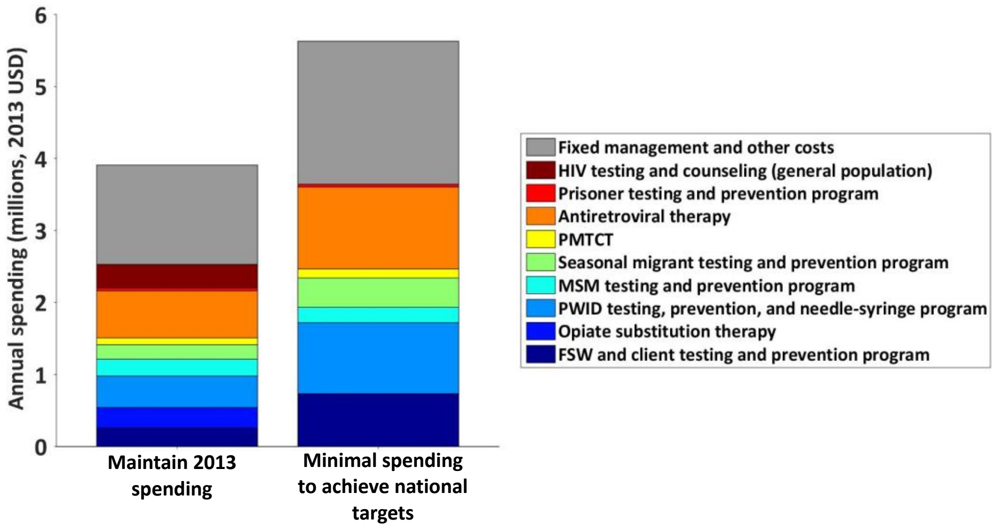
d. ART, OST, PWID programs, and the FSW and client condom and testing program should be prioritized.

e. MSM programs also would be required to achieve national targets. The size of the MSM population is smaller than that of the combined SW/client population, and HIV prevalence among MSM is still lower than among PWID. For these reasons, the estimated numbers of PLHIV and new infections among MSM in Armenia are lower than the numbers among FSW/clients and PWID. These lower numbers also led to the model allocating a lower proportion of funding to MSM programs.

f. The $6 million necessary to achieve national targets in Armenia (point a. above) could avert an additional 600 new infections and 400 AIDS-related deaths over 2015–20.

g. Assuming the budget required to achieve the national targets, the cost per infection and AIDS-related death averted in Armenia would be US$18,900 and US$34,700, respectively.

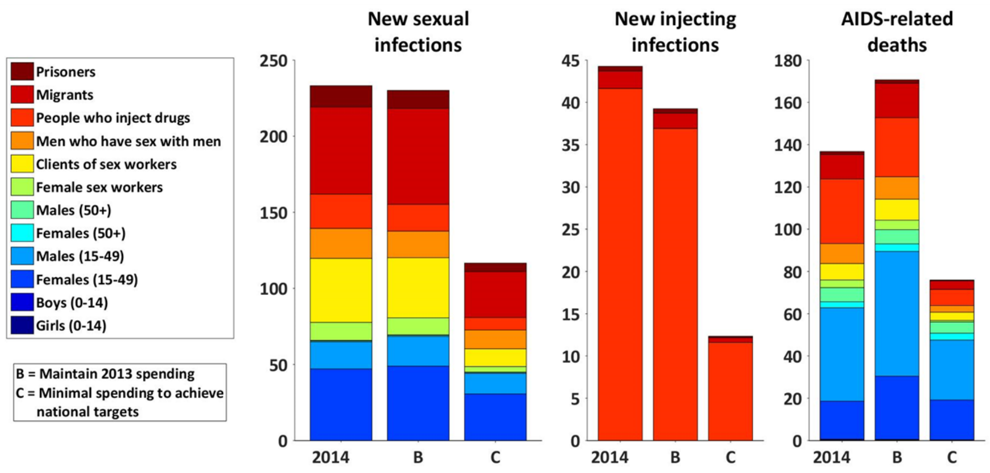
Figure 4.6 Armenia: Minimum annual resource allocation required to achieve 2020 national strategy targets (2013 US$ million)



Source: Populated Optima model for Armenia.

When Armenian national targets are achieved, sexual transmission of HIV will be reduced by almost 50 percent, and transmission by contaminated syringes will be reduced by almost 65 percent (Figure 4.7).

Figure 4.7 Armenia: Comparison of epidemic key outcomes for achieving national targets by 2020



Source: Populated Optima model for Armenia.

Figure 4.8–Figure 4.10 show trends in new infections and deaths under 4 different scenarios:

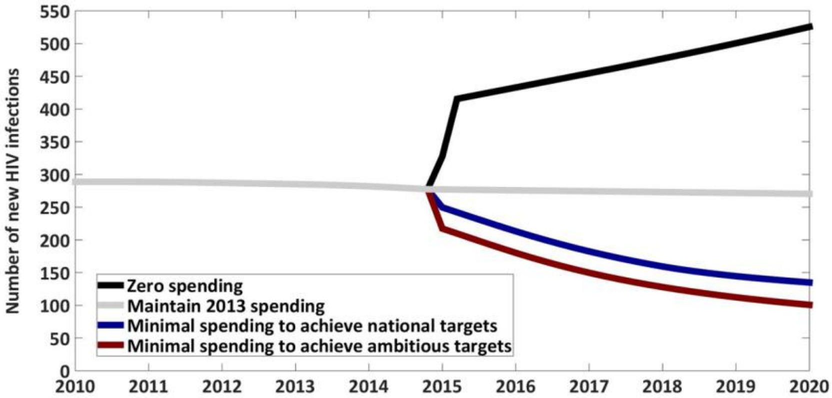
a. **Zero spending** means no investment in HIV programs and would be equivalent to discontinuing all programs.

b. **Maintaining 2013 spending** would imply stable coverage levels of programs.

c. **Minimal spending to achieve national targets** is the level required to achieve at least a 50 percent reduction in new infections and deaths (Figure 4.6).

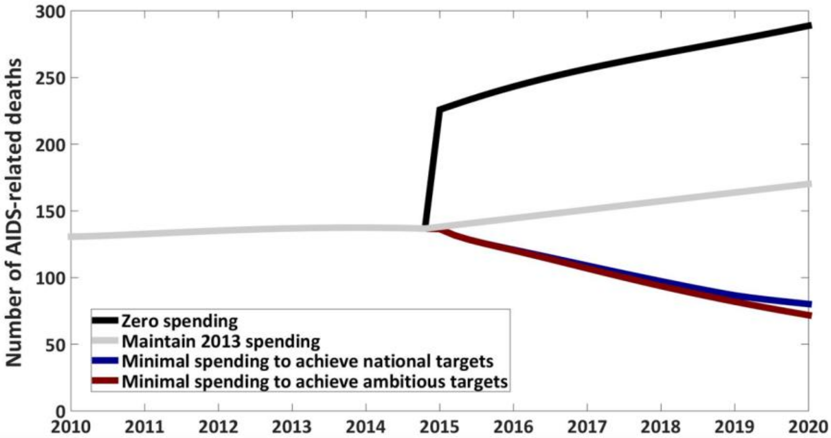
d. **Minimal spending to achieve ambitious targets** refers to the vision of Getting to Zero, defined as 85 percent reduction in HIV incidence and deaths.

Figure 4.8 Armenia: Impact of different investment scenarios on new HIV infections, 2010–20



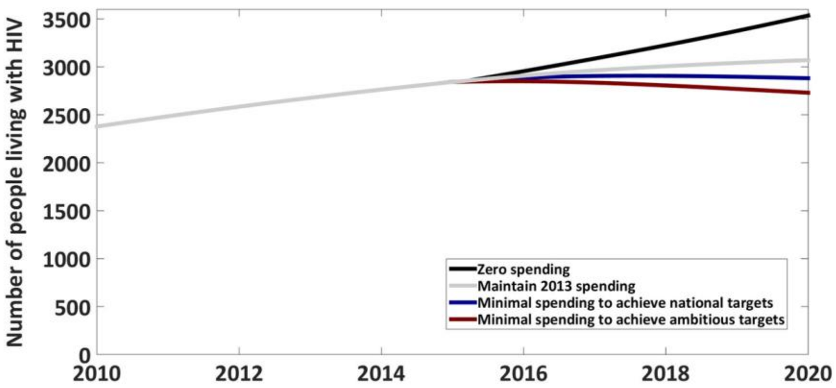
Source: Populated Optima model for Armenia.

Figure 4.9 Impact of different investment scenarios on AIDS-related deaths, 2010–20



Source: Populated Optima model for Armenia.

Figure 4.10 Total number of PLHIV with different spending scenarios, 2010–20



Source: Populated Optima model for Armenia.

Table 4.2 provides the annual allocations from 2015–20 for 2 different optimization results presented in the previous and in this section––optimized allocations of 2013 spending (Figure 4.4) and minimal spending to achieve national targets (Figure 4.6). The 2013 spending allocations are included as a reference for comparison because they served as the baseline scenario (maintaining 2013 spending). Table 4.3 summarizes the levels of program coverage corresponding to the same allocations, including the baseline scenario and the 2 optimized allocations.

Table 4.2 Average annual funding allocations for different spending scenarios from 2015–20 (US$)

Analysis 2015–20	Maintain 2013 spending and allocations	2013 level of spending optimized for both HIV incidence and AIDS-related deaths	Minimal spending to achieve national targets
Allocation to FSW and client condom program	256,000	366,000	934,000
Allocation to opiate substitution therapy	283,000	402,000	1,339,000
Allocation to PWID testing, prevention, and needle-syringe program	438,000	433,000	961,000
Allocation to MSM condom and testing program	235,000	72,000	166,000
Allocation to seasonal migrant testing and prevention program	201,000	179,000	348,000
Allocation to PMTCT	94,000	94,000	208,000
Allocation to antiretroviral therapy	653,000	943,000	1,087,000
Allocation to prisoner condom and testing program	40,000	40,000	40,000
Allocation to HIV testing and counselling (general population)	329,000	0	0
Total annual program spending (direct programs only)	2,529,000	2,529,000	5,083,000
Cumulative program spending, 2015 to end-2020	17,160,000	18,439,000	34,181,000

Source: Populated Optima model for Armenia.
Note: Rounded to 1,000.

Table 4.3 Program coverage levels relating to spending scenarios by 2020 (%)

Analysis to end of 2020	Zero spending	Maintain 2013 spending and allocations	Optimized for both HIV incidence and AIDS-related deaths	Minimal spending to achieve national targets
FSW and client condom program coverage	0	42	56	89
Opiate substitution therapy program coverage	0	4	5	10
PWID testing, prevention, and needle-syringe program coverage	0	40	40	69
MSM condom and testing program coverage	0	47	16	35
Seasonal migrant testing and prevention program coverage	0	51	47	67
PMTCT program coverage	0	93	93	97
Prisoner condom and testing program coverage	0	53	53	53
People living with HIV who know their status	40	62	67	74

Source: Populated Optima model for Armenia.

4.3.2. Costs per HIV infection or death averted

The model-predicted reduction in HIV infections and deaths and the cost per infection and death averted for the optimized allocations is shown in Table 4.4.

Table 4.4 Impact and cost-effectiveness of Armenia HIV programs to end-2020

Analysis to end of 2020	Zero spending	Maintain 2013 spending and allocations	Optimized for both HIV incidence and AIDS-related deaths	Minimal spending to achieve national targets
HIV epidemic impact				
Cumulative new infections	2,800	1,700	1,400	1,000
Cumulative AIDS-related deaths	1,600	1,000	700	600
Number of people living with HIV in 2020	3,700	3,100	3,100	2,900
New infections averted	Baseline	1,200	1,500	1,800
AIDS-related deaths averted	Baseline	600	900	1,000
Cost-effectiveness				
Cost per new infection averted (US$)	Baseline	14,700	12,700	18,900
Cost per AIDS-related death averted (US$)	Baseline	29,100	21,000	34,700

Source: Populated Optima model for Armenia.
Note: Rounded to 100.

4.4 Implications of different spending scenarios on ART

As mentioned, the optimization analyses suggest that the ART program should be prioritized and, in all analyses conducted, that ART coverage should increase to minimize both new HIV infections and AIDS-related deaths. Compared to current spending allocations, the required increase in coverage to achieve national targets translates to approximately 700 additional individuals on first-line treatment, and approximately 300 more individuals on subsequent treatment (Table 4.5).

Table 4.5 ART program indicators for different spending scenarios to 2020

Analysis to end of 2020	Zero spending	Maintain 2013 spending and allocations	Optimized for both HIV incidence and AIDS-related deaths	Minimal spending to achieve national targets
Antiretroviral therapy coverage (eligibility: <500 dx) (%)	0.0	65	86	94
Antiretroviral therapy coverage (eligibility: <350 dx) (%)	0.0	73	90	>95
Those on treatment who are virally suppressed (%)	N/A	95	95	>95
Number on 1st-line treatment	0	700	1,200	1,400
Number on subsequent treatment	0	300	500	600
Number eligible (eligibility: <500 dx)	1,000	1,600	1,900	2,000
Number eligible (eligibility: <350 dx)	800	1,500	1,800	2,000

Source: Populated Optima model for Armenia.
Note: Numbers rounded to 100.

5. DISCUSSION ON MODEL RESULTS AND POLICY IMPLICATIONS

5.1 Epidemic spread and potential

Armenia has a concentrated epidemic, with an estimated adult HIV prevalence of 0.2 percent in the population aged 15–49 years. In the past, as with most countries in the ECA Region, the transmission burden was concentrated primarily in key populations and was driven predominantly by people who inject drugs. However, over recent years, the dynamic of the epidemic in the country has changed: heterosexual transmission has become the dominant mode of transmission.

FSW and their clients, particularly seasonal migrant laborers and their sexual partners, account for a larger proportion of new infections. Short-term labor migration is common in the Region. Individuals move to neighboring countries mostly for work purposes. Seasonal migrant laborers may be separated from spouses or may not have long-term partners, which may increase the rate of partner change. New infections also may be due to the countries of destination, some of which, such as Russia, have substantially higher HIV prevalence than does Armenia.

Assuming that the current budget allocations for the various intervention programs are maintained, the analysis projected a stable epidemic in most of the population groups until 2020. Although, in previous years, the epidemic in the FSW population was growing, the model projects that this epidemic has started to level off and will plateau in the near future. Moreover, and concordant with previous estimates, the Optima model also predicts a declining epidemic in the PWID population, with the epidemic remaining low in the general male and female population.

The Optima model suggests that the national strategy to respond to the HIV epidemic in Armenia has had substantial impacts on the course of the epidemic compared with a zero-spending scenario in which no programs are implemented. The model's projections suggest that the current budget allocation and programs implemented would avert more than 40 percent of the cumulative new HIV infections and 59 percent of AIDS-related deaths up to 2020. The current programs include ART and other programs that target the high-risk population groups including FSW, PWID, seasonal migrant laborers, and MSM.

Policy recommendations:

- In Armenia's **concentrated HIV epidemic, there is continued need to focus analysis, planning, and implementation on key populations**, particularly FSW and their clients, and seasonal migrant laborers and their sexual partners.
- Projections from the model to 2020 show that, compared to a scenario with no spending on HIV programs, the current budget allocations for programs would avert more than 40 percent of the cumulative new HIV infections and 59 percent of AIDS-related deaths.

5.2 Optimal HIV resource allocation for impact and sustainability

The government of Armenia has conducted notable efforts to control the HIV epidemic, and the current budget allocation to various intervention programs could have considerable impact on the course of the epidemic. Nevertheless, the optimization analysis suggests that, to achieve maximum health impacts with the currently available resources, some budget reallocations are necessary.

The analysis suggests that the ART program should be prioritized and that the HIV budget should increase by approximately 40 percent of the current funding allocated to this program. Along with the ART program, the optimization analysis suggests that FSW programs also could benefit, thus reducing both HIV incidence and AIDS-related deaths. Therefore, the budget for the FSW program area also should increase by approximately 33 percent, and 9 percent of the total budget should be allocated to FSW programs. Finally, maximum efficiency of the available budget would be achieved if the OST program funding also were increased by over 33 percent and 10 percent of the total budget were allocated to this program.

Funding for programs such as HIV testing and counselling for the general population should be reduced substantially. Funding for these programs could be reallocated to the programs previously mentioned. The results highlight that the country has accurately allocated resources for programs such as PWID, NSP, and seasonal migrant testing and prevention.

Seasonal migrant laborers have become a vulnerable population at high risk of HIV infection in Armenia. Therefore, the Government of the Republic of Armenia recently implemented a timely and effective testing and prevention program that targets this group. Despite the potentially important role that this population group could play in the country's HIV epidemic, the optimization analysis does not recommend increasing the assigned funding for this program. A number of factors including unit cost, coverage, and program effects will influence the future cost-effectiveness and role of the seasonal migrant laborer program in the HIV response.

Sensitivity analysis of the seasonal migrant laborer program suggests the existence of a cost-effectiveness threshold for this program. The program would be cost effective to fund only if high coverage levels could be reached at relatively low costs compared to other programs. Furthermore, because this migrant labor program was implemented only over the past few years, its epidemiological impact is still undetermined. As a result of this limitation, to completely estimate the impact and understand the effectiveness of this program, the analysts made several important assumptions regarding its effectiveness. More data need to be collected in coming years to strengthen the analysis.

Policy recommendations:

- Despite the government's efforts to control the HIV epidemic and the considerable impact that the current budget allocation could have, the **optimization analysis suggests that some budget reallocations could further improve the health impact of the HIV response** using available resources.
- The analysis suggests that the **ART program should be prioritized** and that the budget should increase by another 40 percent the current funding allocated for this program, taking the investment in ART to over US$900,000 per year on average. This amount would

represent an increase of approximately 18 percent in coverage that would reach almost 86 percent of the total population eligible for treatment by 2020.

- **OST and FSW programs** will continue to be cost-effective interventions. Their funding **also should be increased by approximately 33 percent.**
- Conversely, programs targeting the general population should be ***de***funded. **Funding for general population programs should be reallocated** to the above-mentioned high-impact programs including ART and prevention for key populations.
- The results suggest that current allocations for **prevention programs for PWID** including needle and syringe exchange programs, HTC, and condoms for PWID, **should be sustained**. Meanwhile, analysts should explore whether coverage, quality, and targeting can continue to improve continuously with existing levels of funding.
- **Programs for seasonal migrant laborers** including testing and other prevention services were introduced in response to the increasing contribution of seasonal migrant laborers to new infections. Since these programs are new and their efficacy has yet to be established, the recommendation is to implement a pilot program and **rigorously evaluate the outcomes,** including uptake of HTC and other HIV services.
- Although the model suggests a moderate reduction in investment in the MSM programs, the **MSM epidemic should be monitored carefully**, particularly considering that an HIV epidemic has been growing rapidly among MSM in neighboring Georgia. Thus, MSM programs should be sustained, with a focus on urban sites that have larger MSM populations and continued epidemiological surveillance.

5.3 Funding for health and HIV interventions

To reach the impact goals of Armenia's National Strategic Plan would require increasing the current total budget by 60 percent––or reducing the cost per person reached by nearly 40 percent for all programs. Each option individually may be unrealistic, but combining resource mobilization and technical efficiency gains could achieve national targets. An extra US$2.5 million on top of the 2013 budget of US$3.9 million (or corresponding cost reductions) would avert 1,800 new infections compared to zero spending; and avert 700 new infections by 2020 compared to the current spending without optimization. Optimized allocation of US$3.9 million would still avert an estimated 1,500 new infections compared to zero spending; or 300 new infections compared to maintaining 2013 budgets without optimization. As discussed, optimization analysis recommends prioritizing the scale-up of the ART program. The funding reallocated from the current programs, along with an addition of over US$100,000, would be sufficient to achieve the ART coverage targets proposed in the National Strategic Plan.

Most of the additional funding necessary to achieve the national strategic targets of reducing new HIV infections and AIDS-related mortality by 50 percent should be allocated in programs that target FSW and PWID populations. Approximately US$2 million should be allocated to programs including OST, PWID prevention and needle-syringe program, and FSW and client testing and prevention programs. To fully achieve national targets, funding allocated for seasonal migrant laborer programs should be increased by over 100 percent of the current funding from nearly US$140,000 to roughly US$340,000.

Policy recommendations:

- This analysis did not focus on identifying technical efficiencies or reviewing unit costs; thus, no specific recommendations can be made about them. Making a big-picture comparison to other countries––which has a number of limitations––revealed that costs in Armenia were approximately average and were the median cost for some of the programs. However, costs for PWID and OST programs were above average, which could have been caused by a range of reasons including economies of scale or differences in program packages. Given the limited resources, **it would be worthwhile to conduct additional technical efficiency analyses focusing on the programs that absorb the largest proportion of funding** (ART, OST, PWID/NSP, seasonal migrant laborer programs, and management).

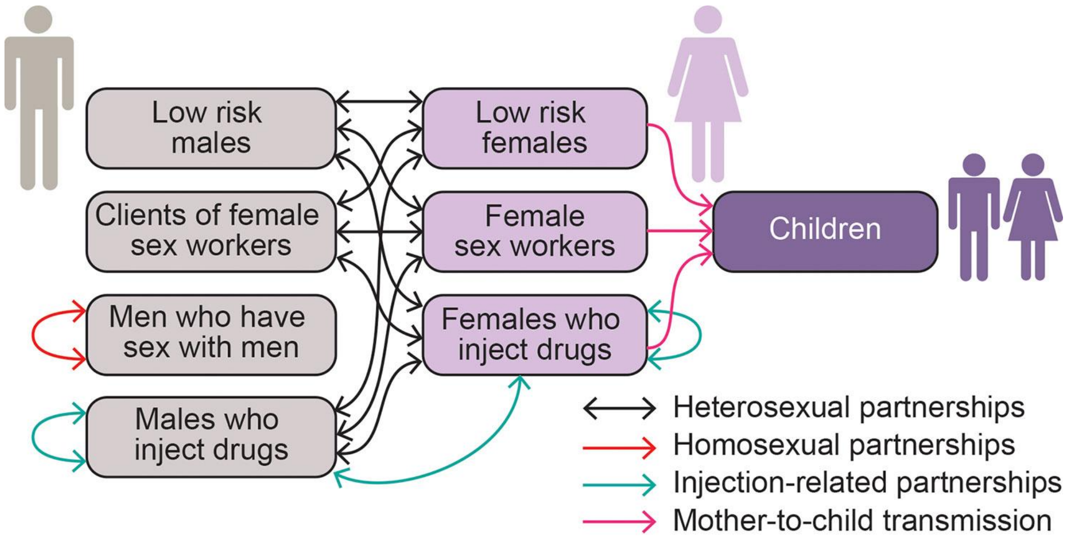
- The Armenian government's 2012 spending on health was 7.9 percent of all government expenditure, which was below the global average of 11.7 percent. By increasing overall government spending on health, Armenia could increase domestic HIV financing to help cover resource gaps in the response, particularly the gap in ART coverage and programs for key and vulnerable populations including PWID, FSW, MSM, and seasonal migrant laborers.

APPENDIXES

APPENDIX A. TECHNICAL SUMMARY OF OPTIMA

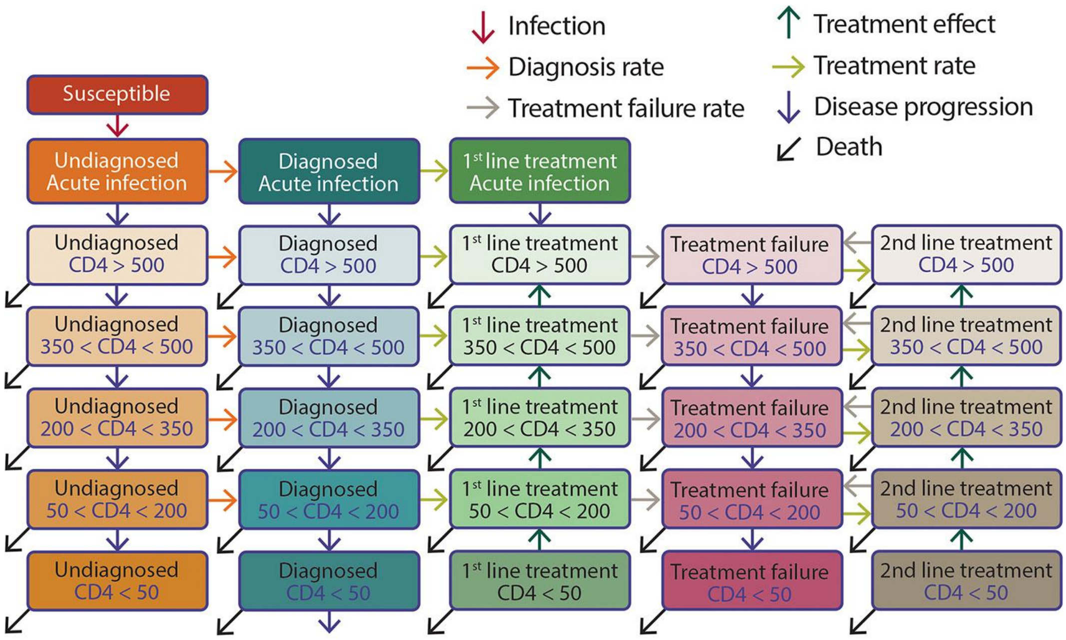
Appendix A provides a brief technical overview of Optima. A more detailed summary of the model and methods is provided elsewhere (Kerr and others 2015). Optima is based on a dynamic, population-based HIV model. Figure A.1a summarizes the populations and mixing patterns used in Optima. Figure A.1b shows 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.[6] HIV infections occur through the interactions among different populations by regular, casual, or commercial (including transactional) sexual partnerships; through sharing of injecting equipment; or through mother-to-child transmission. The force-of-infection is the rate at which uninfected individuals become infected. The rate depends on the number and type of risk events to which individuals are exposed in a given period (either within their population groups or through interaction with other population groups) and the infection probability of each event. Mathematically, the force of- infection has the general form:

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

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

6 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.[7] 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.[8] 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.[9]

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7 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.

8 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.

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

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

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

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: 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.[10] 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.[11] 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,

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10 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).

11 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).

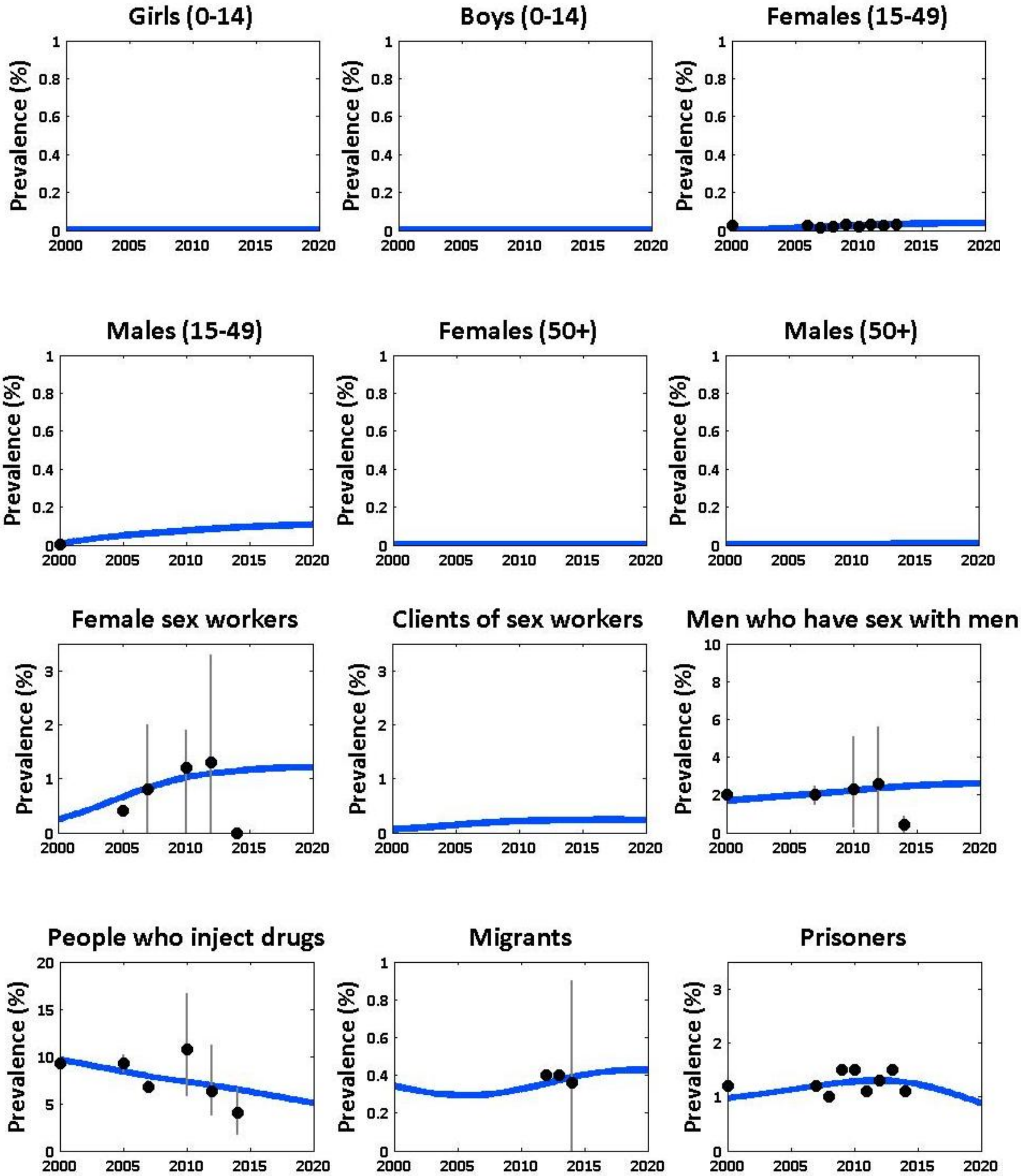
users define upper and lower limits for both coverage and behavior for no spending and for very high spending.[12]

[12] 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

Calibration was performed using Armenia's HIV data for 2000–15 including all available demographic, epidemiological, behavioral, and clinical data. These calibrations were produced in collaboration with Armenian government representatives and experts.

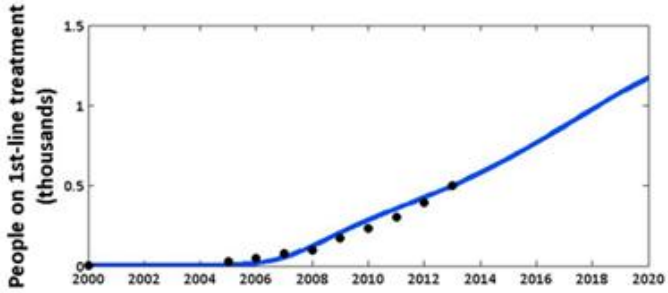
Figure B.1 Armenia: Modeled HIV prevalence by population group, 2000–20 (%)



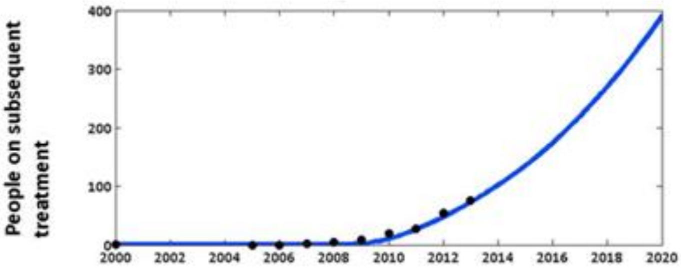
Source: Populated Optima model for Armenia.
Note: Black dots = available data for HIV prevalence; Solid curves = calibration to HIV prevalence for each population.

Figure B.2 Armenia: Modelled number of people on first-line and subsequent treatment, 2000–20

a. 1st-line treatment



b. Subsequent treatment



Source: Populated Optima model for Armenia.

APPENDIX C. COST-COVERAGE-OUTCOME CURVES

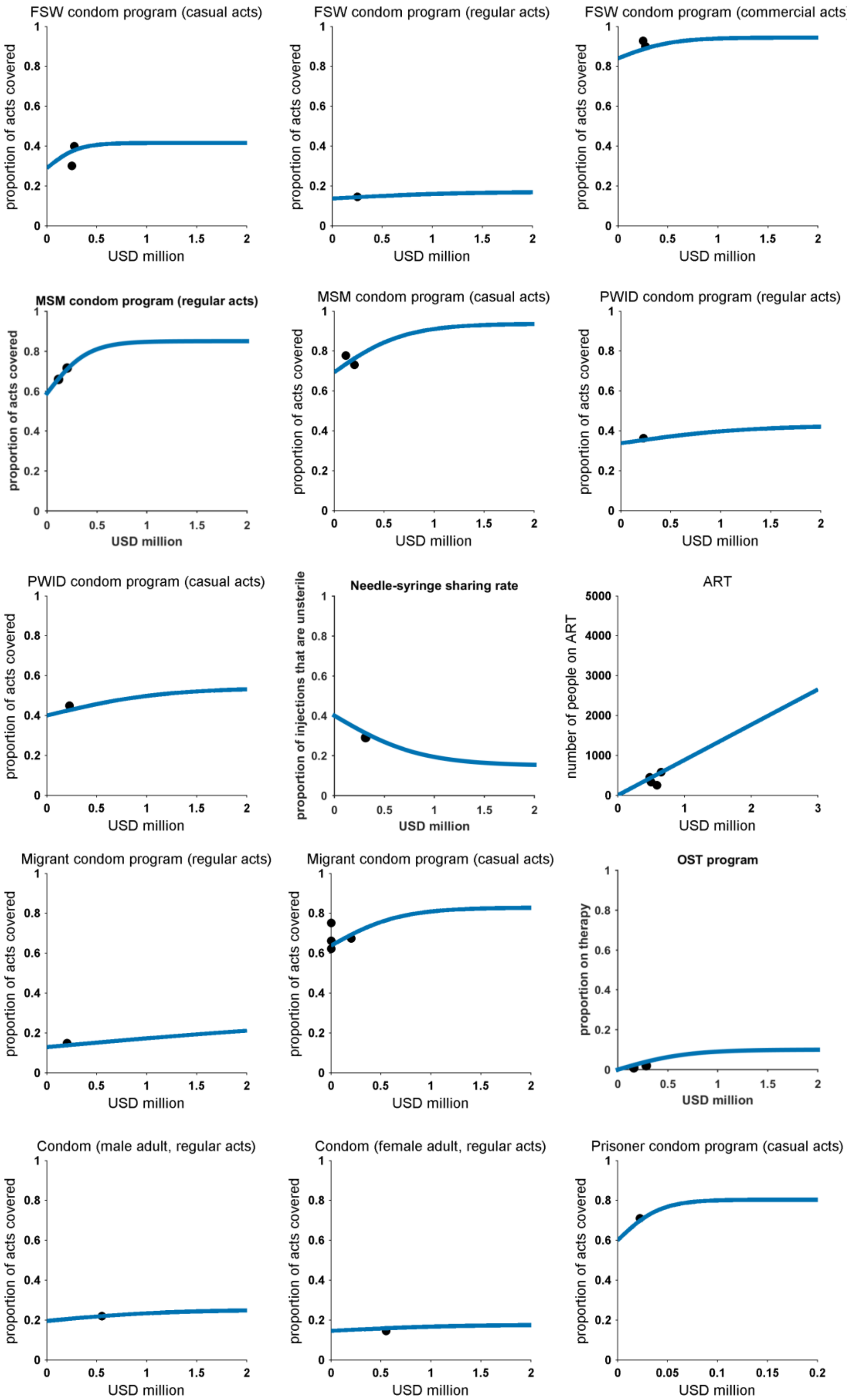
Following the calibration of HIV prevalence and treatment data, cost-outcome curves were developed for the nine programs included in the optimization. These curves define the relationship between program expenditure and respective outcomes (such as HIV testing rate, condom use per population, or number of people on ART) and are critical for the optimization analysis.

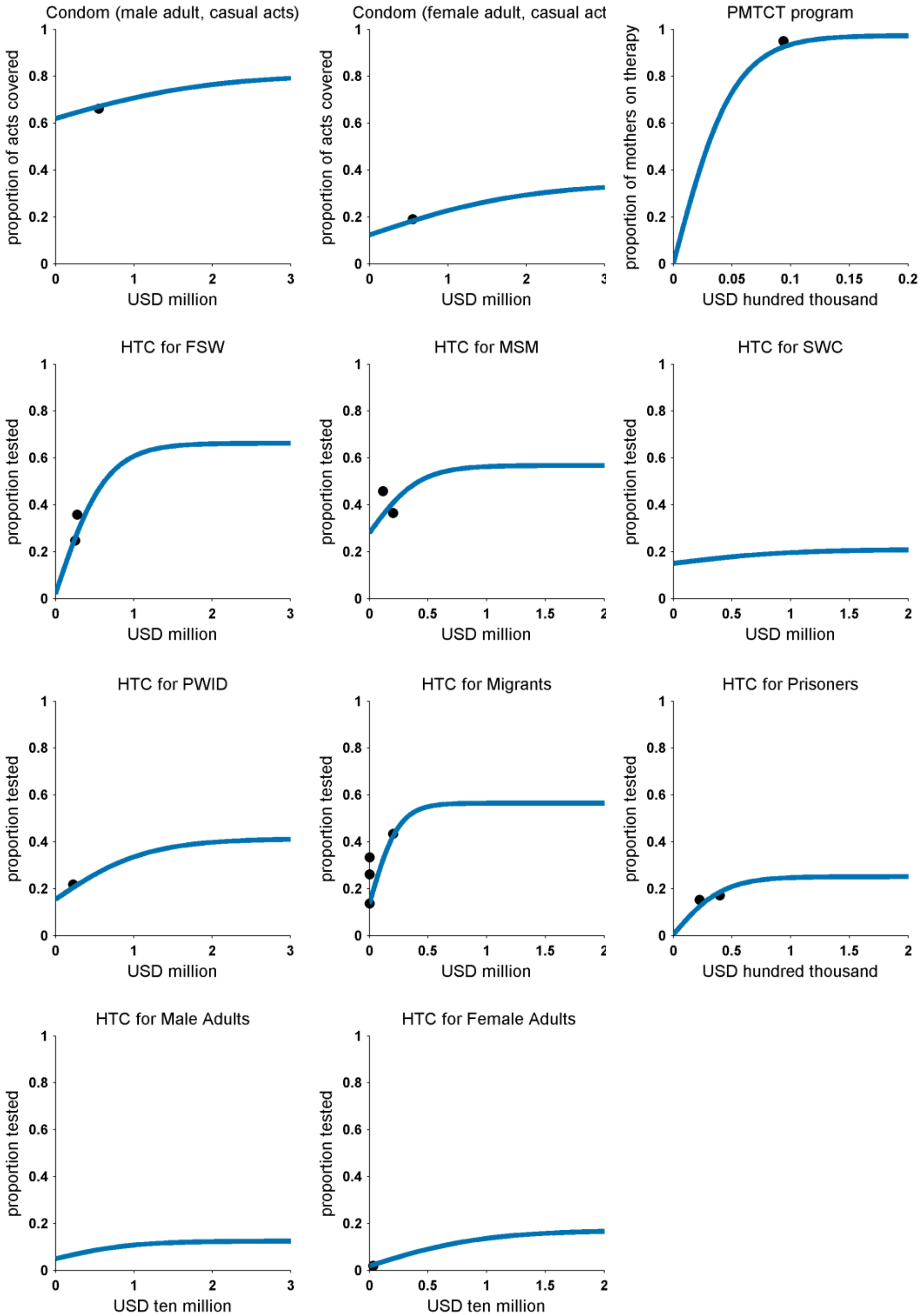
Appendix C contains the full set of cost-outcome curves introduced in chapter 3.

A cost-coverage curve represents the level of output (that is, the level of service coverage to a given population) that can be achieved given a certain amount of spending. An example would be how many female sex workers would be provided with a standard package of services with an investment of US$0–US$1,000,000. The association between coverage levels and outcome is determined in a separate relationship. This relationship describes the proportion of people who will adopt a specific behavior (such as condom use or consistent use of antiretroviral therapy leading to viral suppression). The cost-coverage and coverage-outcome relations then are aggregated into cost-outcome relationships, which directly link money spent to outcome in form of behavior such as condom use or HIV testing. All of these relationships were produced in collaboration with national experts for Armenia. Figure C.1 includes the actual cost-outcome curves for various behaviors and populations.

These cost-coverage curves then are used in the mathematical optimization provided by the Optima model, which is the analytical step to determine the "best" allocation. In this process, different objectives (such as minimizing HIV incidence or HIV costs) will yield different optimal allocations of resources or spending. The model determines the resource allocation required that best meets the objective.

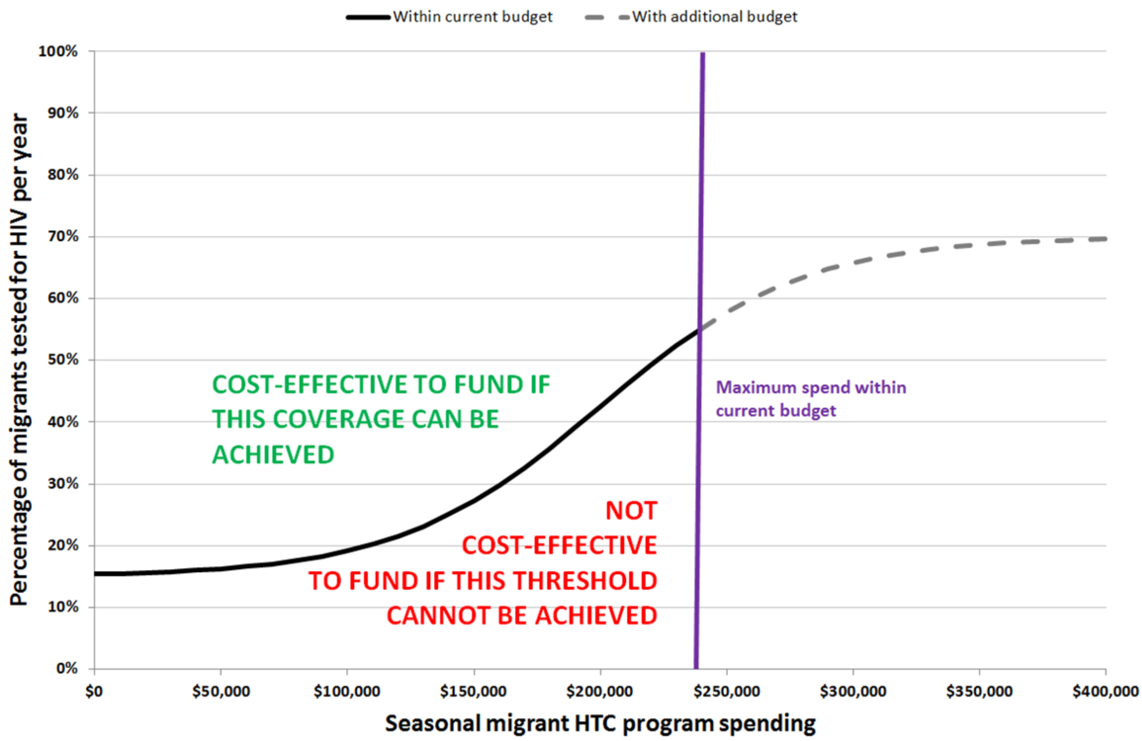
Figure C.1 Cost-coverage outcome curves for Armenia (US$)





Source: Populated Optima model for Armenia.

Figure C.2 Cost-outcome sensitivity analysis for seasonal migrant HIV testing and counselling (HTC)



Source: Figure prepared by the authors.

APPENDIX D. GLOSSARY

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

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

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