Optimizing Investments in the Former Yugoslav Republic of Macedonia's HIV Response

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OPTIMIZING INVESTMENTS IN FORMER YUGOSLAV REPUBLIC OF MACEDONIA'S HIV RESPONSE

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ABBREVIATIONS

AE	allocative efficiency
AIDS	aquired immune deficiency syndrome
ART	antiretroviral therapy
ARV	antiretroviral
BOD	burden of disease
CCOCs	cost-coverage outcome curves
CI	Confidence interval
Clients	clients of sex workers
DALY	disability-adjusted life year
ECA	Europe and Central Asia
ENV	enabling environment
EU	European Union
Females 15+	females 15 years old and older, excluding the other population groups in this age group
FSW	female sex workers
FYR Macedonia	Former Yugoslav Republic of Macedonia
GARPR	Global AIDS Progress Reporting
GDP	gross domestic product
Global Fund	The Global Fund to Fight AIDS, Tuberculosis and Malaria
HIV	human immunodeficiency virus
HR	human resources
HTC	HIV testing and counseling
IBBSS	integrated bio-behavioral surveillance survey
IDU	injecting drug use
IEC	information, education and communication
INFR	health infrastructure
Males 15+	male 15 years old and older excluding the other population groups in this age group
MGMT	management
M&E	monitoring and evaluation
MSM	men who have sex with men
MSW	male sex workers
NASA	national AIDS spending assessment
NCD	non-communicable disease
NGO	non-governmental organization
NHA	national health accounts
OST	opiate substitution therapy
PrEP	pre-exposure prophylaxis
PLHIV	people living with HIV
PMTCT	prevention of mother-to-child transmission
PWID	people who inject drugs
SBCC	social and behavior change communication
STI	sexually transmitted infection
THE	total health expenditure
UNSW	University of New South Wales
WHO	World Health Organization
YLL	years of life lost

EXECUTIVE SUMMARY

The Former Yugoslav Republic (FYR) of Macedonia experiences a low level, concentrated HIV epidemic. The small number of people currently living with HIV is attributable, in part, to an effective HIV response to date.

There is increasing HIV prevalence among certain key population groups, particularly men who have sex with men (MSM) and male sex workers (MSW). This recent trend warrants early attention.

MSM accounted for 64% of newly diagnosed people living with HIV in 2014. In that same year, programs specifically targeting MSM accounted for only 2.4% of HIV spending. This suggests under-coverage of this key population.

HIV prevalence amongst MSM was estimated at 2% in 2014[1] and according to Optima projections, is predicted to increase to approximately 6% by 2030. **Given the projected increase in HIV incidence and prevalence among MSM, increasing resources to, and coverage of, MSM programs would increase the effectiveness of the HIV response.**

The HIV epidemic in the general population in FYR Macedonia is expected to remain at a very low level—increasing slightly from an estimated 0.004% in 2014 to 0.010% in to 2030 among women, and from 0.002% in 2014 to 0.005% in 2030 for men. The small expected increase in HIV prevalence amongst females is largely attributed to increasing HIV prevalence amongst MSM, many of whom also have female partners (64.9%[2] in 2014 and 77% in 2010[3]). **As such, prevention and treatment programs targeted at MSM should provide a cost-effective strategy for minimizing new infections in the general population.**

HIV prevalence amongst female sex workers (FSW) and their clients is predicted to increase only slightly from an estimated 0.05% in 2014 to 0.06% by 2030 for FSW, and 0.005% to 0.007% for their clients when assuming that current conditions of behaviours and levels of program coverage are sustained.

HIV prevalence amongst MSW is expected to increase from an estimated 3.4%[4] in 2014 to approximately 7% by 2030 under current conditions. Whilst the MSW population is small, HIV prevalence is relatively high and therefore interactions between MSM and MSWs remain an important driver of HIV transmission in this setting. **The MSW population should therefore be the primary focus of sex worker HIV programs, although the wider sexual and reproductive health needs of FSW remain an important public health priority.**

1 Mikik et al, 2014b. Report on the bio-behavioural study among "men having sex, with men" population in Skopje, Macedonia, 2013-2014.

2 Ibid.

3 Mikik, 2012. Report from the bio-behavioural study and assessment of population size of man having sex with man in Macedonia, 2010. Skopje: Institute for pubic health of Republic of Macedonia.

4 Mikik et al, 2014b.

HIV prevalence estimates from IBBS studies and NGO testing data indicate a decline in HIV prevalence among people who inject drugs (PWID), from 0.42% in 2006[5] to 0.12% in 2014[6]. Needle sharing rates have also decreased from 9.7%[7] in 2009 to 3.6% in 2014[8]. This suggests that programs targeted at this population have been effective. The model suggests that this downward trend may continue unless there is a substantive change in the risk factors for this population. However, given the relatively high cost of Opiate Substitution Therapy (OST) in FYR Macedonia, further technical efficiency analyses may be beneficial in identifying ways to reduce the cost of this program without compromising the scope of delivery.

Optimizing current spending could reduce HIV deaths and new infections substantially, and potentially avert a predicted future increase in the epidemic. The allocative efficiency of FYR Macedonia's current programs could be improved by increasing investment in ART and MSM programs (Figure E1). If the current annual budget of around 5.5[9] million USD were allocated optimally among key populations and programs, an additional 860 new infections and 290 additional deaths could be prevented by 2030.

Optimized allocations require substantial increases in funding for ART from US$ 0.3 to 1.3 million and for MSM programs from US$ 0.1 to 0.3 million. As the optimization analysis was related to HIV outcomes only and based on current epidemic trends, programs for other populations were less critical. Funds for HIV prevention in the general population could be entirely reprogrammed into ART and MSM programs. Programs for female sex workers and needle-syringe programs will still be important for prevention of other infections and wider public health objectives. Also, our model is based on country-specific epidemic dynamics and due to mobility of key populations such as FSW and PWID, risk in these populations might change. Therefore programs for FSW as well as harm reduction for PWID including both OST and NSP should be continued.

The burden of HIV in FYR Macedonia is increasing from a low base. Without improvements in the allocative efficiency of HIV programming, the model predicts that overall HIV incidence will increase from 0.002 in 2014 to 0.006 in 100 person years by 2030. **With an optimized allocation of current resources, the number of new HIV infections could be reduced by as much as 85%.**

Current annual spending will be enough to achieve National HIV Strategic Plan and international targets, but only if allocated optimally. With an optimized allocation of funding, annual future spending commitments attributable to new infections may be reduced.

Although funding for HIV in FYR Macedonia has increased since 2008, international donors have financed much of this increase. Prevention programs and programs targeted at key populations, are primarily funded by international donors. As such, the withdrawal of international funding, without a concurrent increase in domestic funding, will have a significant negative impact on the HIV epidemic in Macedonia. Therefore, transitional funding mechanisms need to be explored with the aim of raising domestic funding to at least the level of the current total budget for the HIV response. **International donor funding must be**

5 Ministry of Heath of Republic of Macedonia, 2008. Bio-behavioral study conducted among young people and most at risk populations for HIV infection in Republic of Macedonia in 2007.

6 NGO testing data 2014. 1 diagnosed PLHIV out of 815 PWID tested.

7 Mikik et al.,2010. Report from the bio behavioural survey and assessment of population size of injecting drug users in Macedonia, 2010. Skopje: Institute for public heath of Republic of Macedonia.

8 Mikik et al, 2014c. Report on the bio-behavioural study among people who inject drugs in Macedonia, 2014

9 This figure does not include spending on Hepatitis C.

replaced with alternate funding and that funding spent on an optimal mix of prevention programs targeted at key populations and the scale up of ART delivery.

Preparing for domestic financing of programs for key populations will also require the **decision on and development of contracting mechanisms for NGOs reaching out to key populations, in particular MSM.** This is required to ensure that there are strong linkages between community-based prevention, demand generation for HTS and ART.

Figure E 1 Comparing the allocation of 2013 spending against its optimized allocation

Source: Populated Optima model for FYR Macedonia.

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1. BACKGROUND: WHY ALLOCATIVE EFFICIENCY ANALYSIS NOW?

1.1 FYR Macedonia's health and health financing context

1.1.1. Burden of disease

The leading cause of burden of disease in 2013, measured by disability adjusted life years (DALYs) in FYR Macedonia is lung cancer, followed by diabetes and ischemic heart disease[10]. In the age group most affected by HIV, i.e., 15-49 years, the leading cause of burden of disease is musculoskeletal disorders, mental and substance use disorders and other non-communicable diseases (NCDs)[11]. NCDs are the leading cause of burden of disease in FYR Macedonia, making up 81% of DALYs amongst 15-49 year olds, followed by injuries (14%) and communicable, maternal, neonatal and nutritional diseases (5%). The burden of disease due to HIV and Hepatitis (A, B and C) are similar with 66 and 63 DALYs respectively, whilst tuberculosis accounts for 554 DALYs amongst 15–49 year olds in FYR Macedonia[12].

1.1.2. Health care financing and expenditure

The health system of the FYR Macedonia is financed primarily through compulsory health insurance. In this context, compulsory health insurance provides universal coverage, and its basic benefits package including both treatment and prevention services, is considered comprehensive. Insurance contributions are collected through a payroll-based system, collected and managed by the Health Insurance Fund. The state budget from non-hypothecated sources and patients' co-payments in form of out of pocket expenses, constitute additional sources of financing[13].

According to World Health Organization (WHO) estimates for 2013[14], total health expenditure as a percentage of gross domestic product (GDP) in FYR Macedonia was 6.4%, showing a reduction of around 30% since 2000 (see Table 1.1). This figure is lower than the WHO Europe regional average (8.0%) and significantly lower than most other ex-Yugoslav countries such as Serbia with 10.6%, Bosnia and Herzegovina with 9.6% and Slovenia 9.2% (see Figure 1.1). In 2013, per capita health care expenditure was US$ 312 and nearly 70% of health expenditure was funded from public sources (see Table 1.1). Expenditure from public sources has increased by almost 20% since 2000, while out-of-pocket payments have decreased from 42% to 31% of total health expenditure (see Table 1.1).

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10 University of Washington, Institute for Health Metrics and Evaluation (2013): 2013 Global Burden of Disease, Injuries and Risk Factors Study. Data Visualizations. http://www.healthdata.org/macedonia

11 Ibid.

12 Source: University of Washington, Institute for Health Metrics and Evaluation (2013): 2013 Global Burden of Disease, Injuries and Risk Factors Study. Data Visualizations. http://vizhub.healthdata.org/gbd-compare/patterns

13 Gjorgjev D, Bacanovic A, Cicevalieva S, Sulevski Z, Grosse-Tebbe S. The former Yugoslav Republic of Macedonia: Health system review. Health Systems in Transition, 2006; 8(2):1–98.

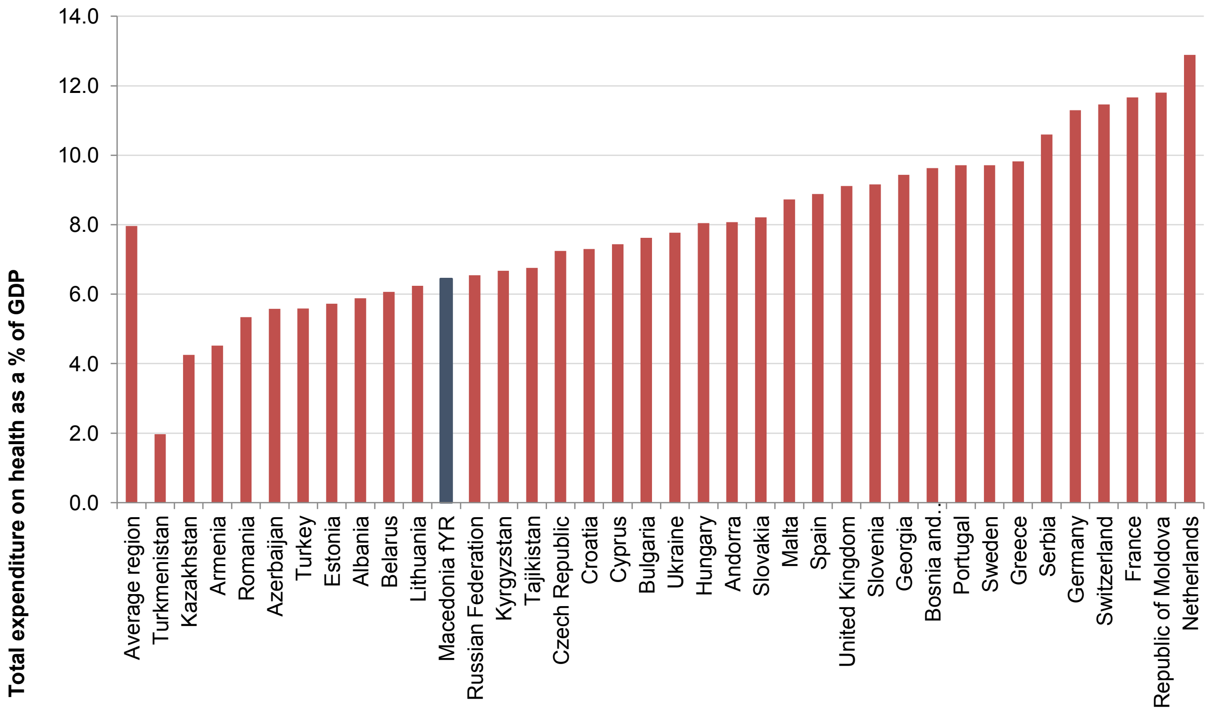
14 WHO National Health Accounts Database (http://apps.who.int/nha/database/Select/Indicators/en)

Table 1.1 Trends in health expenditure in the FYR Macedonia, 2000–13

Indicator	2000	2005	2010	2011	2012	2013
GDP (current prices, US$, millions)	3,595	5,988	9,355	10,410	9,577	10,215
Total health expenditure (US$, millions)	314	484	640	697	660	658
Total health expenditure (US$ per capita)	153	231	304	331	314	312
Total health expenditure as a percentage of GDP	8.7	8.1	6.8	6.7	6.9	6.4
Government health expenditure as a percentage of total health expenditure	58	62	63	64	65	69
Private health expenditure as a percentage of total health expenditure	42	38	37	36	35	31
Government health expenditure as a percentage of total government expenditure	15	14	13	13	13	13
External resources for health as a percentage of total health expenditure	3	2	1	1	1	<1
Social security expenditure on health as a percentage of total government expenditure	97	96	92	92	92	92
Out-of-pocket health expenditure as a percentage of total health expenditure	42	38	37	36	35	31

Source: WHO National Health Accounts Database (http://apps.who.int/nha/database/Select/Indicators/en).

Figure1.1 Total expenditure on health as a % of GDP in the WHO European Region (selected countries), 2013, WHO estimates



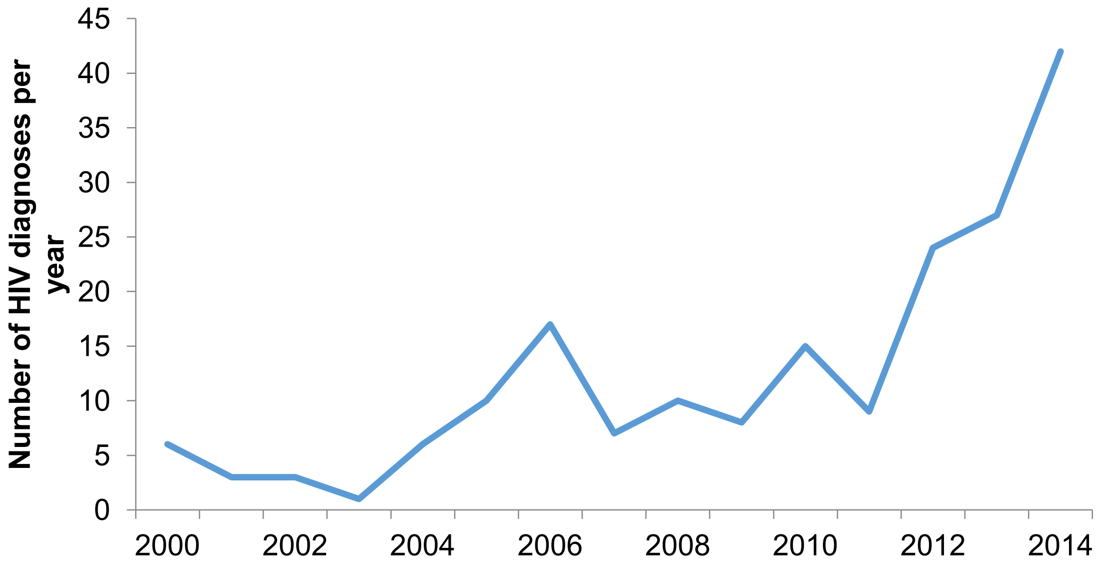
Source: WHO National Health Accounts Database (http://apps.who.int/nha/database/Select/Indicators/en).

1.2 The HIV epidemic appears to be slowly growing in FYR Macedonia

FYR Macedonia has a low level HIV epidemic. Since the detection of the first case of HIV in 1987, 236 people have been diagnosed with HIV[15] and 75 registered AIDS deaths were recorded by 1 December 2014[16]. However, the number of people diagnosed has increased in recent years, with 39 out of the 236 registered people living with HIV (PLHIV), diagnosed in 2014 alone (Figure 1.2). The HIV epidemic in this context is concentrated among males (80%), and 64% of newly diagnosed PLHIV in 2014 were men who have sex with men (MSM)[17]. There have also been small numbers of new diagnoses among other key populations, including male sex workers (MSW) and people who inject drugs (PWID). Cases amongst the general population are low in number.

A significant proportion of PLHIV are not aware of their status as indicated by the late diagnoses in 2014, where 41% of newly diagnosed PLHIV already had AIDS[18]. Poor detection leads to late presentation for treatment. This in turn adversely affects treatment outcomes, significantly increases short-term mortality risk and reduces the cost effectiveness of treatment. The introduction of antiretroviral therapy (ART) has reduced mortality amongst PLHIV over recent years, but these data suggest that earlier detection could significantly improve the effectiveness of ART.

Figure1.2 Number of registered HIV cases



Source: National HIV program database.[19]

1.3 Financing the HIV response in FYR Macedonia

1.3.1. HIV response has been heavily dependent on donors contribution

Total HIV spending in FYR Macedonia increased by nearly 80% between 2008–13 (Figure 1.3). Most of this increase is due to substantial growth in international funding (Figure 1.4). The

15 Institute of Public Health of Republic of Macedonia. 2015. Facts about HIV/AIDS in the Republic of Macedonia for 2014. http://iph.mk/en/facts-about-hiv-aids-in-the-republic-of-Macedonia-for-2014/.

16 Ibid.

17 Ibid.

18 Ibid.

19 Ibid.

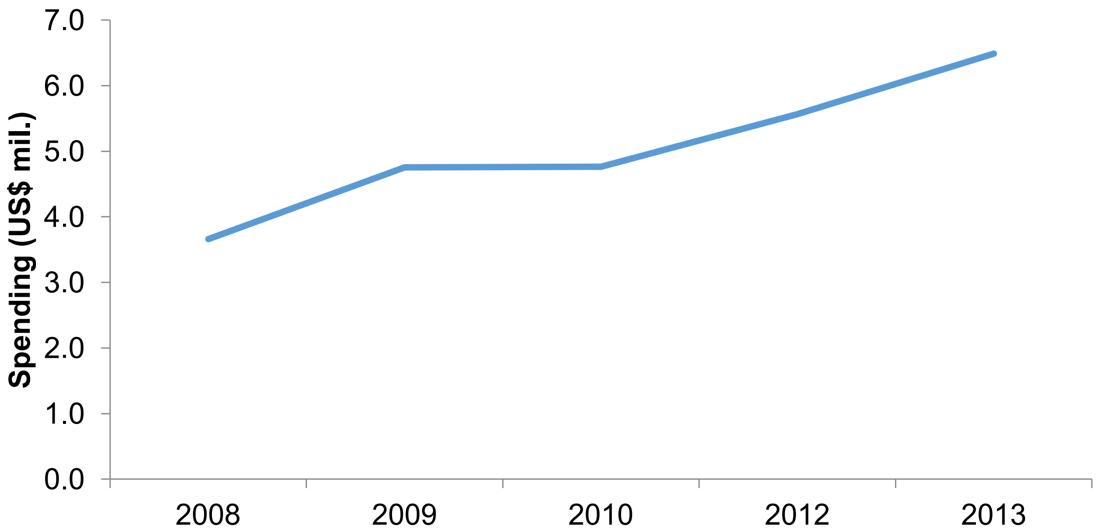
Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) has been the country's major international donor, contributing around 90% of all donor funds in 2013.

In 2013, domestic funding (combined state and private spending) was marginally higher than international funding (with 53%). Domestic funding has increased around 70% since 2008, almost entirely due to the substantial growth in public HIV funding. It should be considered that private spending in this context only includes contributions made from charitable organizations and do not include household (out-of-pocket) spending, and is therefore likely to be underestimated.

The current National Strategy for HIV/AIDS will expire at the end of 2016, together with the financial support of the Global Fund. A new national strategic plan for 2017–21 is thus being developed in a new funding climate, amid concern for the sustainability of FYR Macedonia's HIV response. In response, a sustainability and transition plan is being simultaneously developed to identify transitional funding mechanisms and facilitate the shift from international to domestic financing of HIV programs.

Current reliance on international donors for a substantive portion of HIV financing, coupled with a substantial expected reduction in international assistance in the short-term, are key challenges to the sustainability of HIV programming in FYR Macedonia. These challenges will be compounded if HIV incidence continues to rise. Further reducing of FYR Macedonia's dependence on external donor funding may require the establishment of transitional funding mechanisms to supplement and redirect public funding sources.

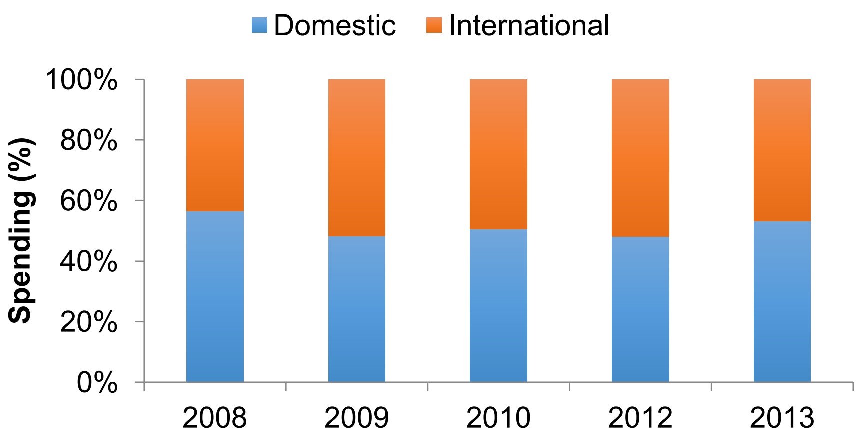
Figure 1.3 Overall spending on HIV/AIDS in FYR Macedonia



Source: Ministry of Health. 2014. National HIV/AIDS Spending report 2008–13.[20]

[20] Data on HIV spending for 2011 was not available.

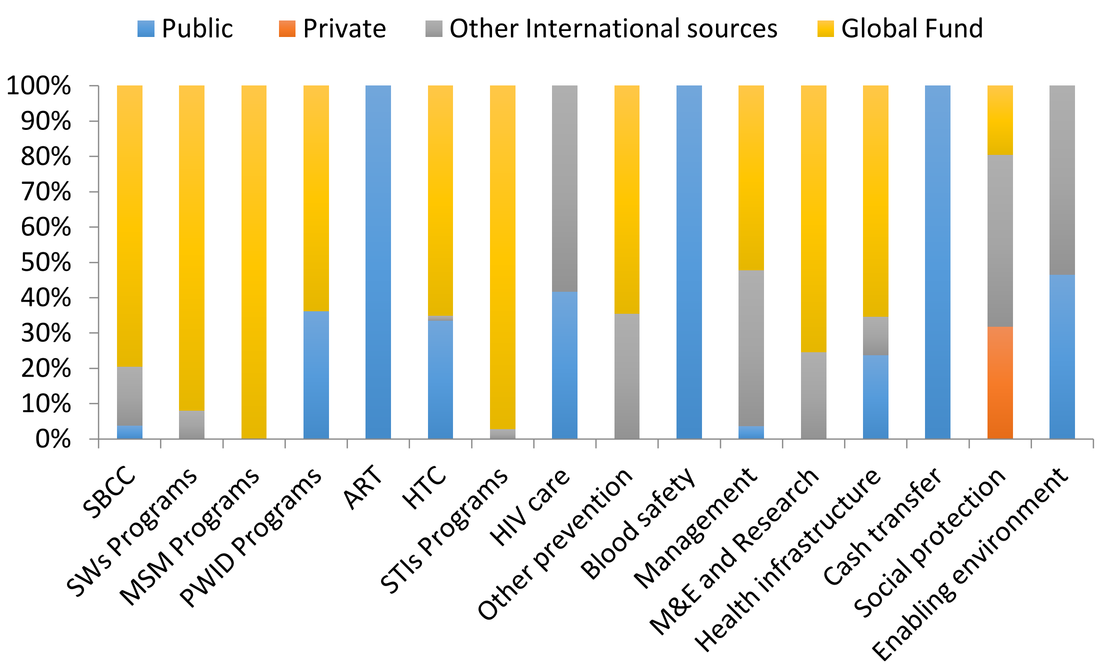
Figure 1.4 Funding for HIV in FYR Macedonia, by funding source



Source: Ministry of Health. National HIV/AIDS Spending report 2008-2013.

Funding for the HIV response, including the component funded by the Global Fund, is further explained in Figure 1.5. The programs currently funded by the Global Fund are of particular significance given the withdrawal of financial support from the Global Fund.

Figure 1.5 Funding for HIV in FYR Macedonia, by funding source including Global Fund, 2013



Source: Ministry of Health. National HIV/AIDS Spending report 2008-2013.[21]

1.4 A need for allocative efficiency

In the current environment of increasingly limited resources for HIV epidemic responses, focused design and efficiency in program delivery are essential to ensure that programs can do more with less.

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[21] Public funds include both the state and health insurance funds. Private funds for social protection were HIV specific income generation activities funded by an NGO. Other international funds mainly include funds from United Nations agencies, and other organizations such as International Planned Parenthood Federation. HIV care includes all inpatient and outpatient care excluding ART.

A shift towards investment thinking in the design of HIV responses is being promoted by UNAIDS and co-sponsors globally, in order to maximize the impact of program investment and best realize the long-term health and economic benefits of HIV programs. Investment cases are currently being developed by a number of countries to understand HIV epidemics as well as to design, deliver and sustain effective HIV responses. In support of HIV investment cases, a group of countries in the ECA region are in the process of conducting allocative efficiency analyses. In 2014 and 2015, allocative efficiency analyses were carried out in Armenia, Belarus, Bulgaria, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan[22], Ukraine[23] and Uzbekistan[24]. This report summarizes the results of a similar allocative efficiency analysis for FYR Macedonia.

In addition, this report provides insights on the progress made towards reaching key international commitments. In the 2011 UN Political Declaration, countries agreed to reduce sexual and injection-related transmission by 50%, virtually eliminate HIV mother-to-child-transmission, initiate 80% of eligible PLHIV on treatment and end HIV-related discrimination by 2015[25]. The 2014 Gap Report[26] illustrated that substantial additional effort will be required in most countries to achieve these targets. Against this background, UNAIDS globally defined a **Fast-Track**[27] strategy in order to achieve the goal of *Ending AIDS by 2030.* This includes new initiatives such as the 90-90-90 targets[28]. These set out to ensure that 90% of all PLHIV are diagnosed, 90% of diagnosed PLHIV are on ART and 90% of PLHIV on ART are virally suppressed. The Fast-Track approach also emphasizes the need to focus on the geographical areas and communities most affected by HIV and recommends that resources be concentrated on the programs with the greatest impact.

In the context of this report, the investment case is complemented with a human rights-based approach to health care. FYR Macedonia is one of the countries in ECA to have signed up to the 2004 'Dublin Declaration of Partnership to fight HIV/AIDS in Europe and Central Asia'[29]. As confirmed in the current national strategic plan[30], a universal approach based on upholding human rights and non-discrimination is to be adopted, including prevention, treatment, care and support services.

1.4.1. Allocative efficiency in HIV

The concept of allocative efficiency refers to the maximization of health outcomes, with the least costly mix of health interventions, within a defined budget envelope. HIV allocative efficiency studies generally try to answer the question "*How can* a given *HIV funding amount be*

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22 Republic of Tajikistan (2014). Modelling an optimized investment approach for Tajikistan: Sustainable financing of national HIV responses. Authors: Hamelmann C., Duric P., Kerr C., Wilson D.P., Dushanbe, Ministry of Health. http://www.eurasia.undp.org/content/dam/rbec/docs/UNDP%20Modelling%20Tajikistan_English.pdf

23 This study is part of a regional initiative of conducting HIV allocative efficiency analysis in 11 countries in the ECA region. Aspects of the analytical process and the presentation of findings have been based on the Optima analyses and accompanying reports for other countries in the region.

24 Republic of Uzbekistan (2015). Modelling an optimised investment approach for Uzbekistan: Sustainable financing of national HIV responses. Lead authors: Duric, P., Hamelmann, C., Wilson, D., Kerr, C. http://optimamodel.com/pubs/uzbekistan-report.pdf

25 United Nations General Assembly (2011). Resolution adopted by the General Assembly 65/277. Political declaration on HIV and AIDS: Intensifying our efforts to eliminate HIV and AIDS. New York.

26 UNAIDS (2014c). The gap report. Geneva.

27 UNAIDS (2014b). Fast-track. Ending the AIDS epidemic by 2030. Geneva.

28 UNAIDS (2014e). 90-90-90 An ambitious treatment target to help end the AIDS epidemic. Geneva.

29 Dublin Declaration on Partnership to fight HIV/AIDS in Europe and Central Asia. Breaking the Barriers—Partnership to fight HIV/AIDS in Europe and Central Asia conference; 2004, Feb 23-24; Dublin, Ireland.

30 Macedonia, FYR. 2012. National Strategic Plan 2012–16.

optimally allocated to the combination of HIV response interventions that will yield the highest impact?"

There is wide consensus that better outcomes could be achieved in many settings with a given amount of HIV funding, or that given outcomes could be achieved with less HIV funding, if resources were distributed optimally or if resources were used in the most efficient ways. Mathematical modeling is one way to determine optimized HIV resource allocation within defined budget envelopes. The HIV allocative efficiency (AE) analysis in this study was carried out using the Optimization and Analysis Tool (Optima). The results can be utilized to serve the needs of decision-makers and health planners seeking to improve the allocative efficiency of their HIV financing.

2. HOW WILL THIS REPORT ANSWER KEY POLICY QUESTIONS?

This report summarizes how FYR Macedonia may be able to better allocate current HIV spending, to maximize health outcomes and minimize new HIV infections and HIV related deaths. The findings of this report can assist the government in further strengthening its HIV investment case, through which it attempts to increase the effectiveness of HIV investments and define corresponding priorities, strategies and impacts of the HIV response. This is pertinent in the current context of sustainability financing, with a need to shift from international to domestic funding.

2.1 The Optima Model

To assess HIV epidemic trends we use Optima's epidemic module, which consists of a mathematical model of HIV transmission and disease progression. Optima uses best-practice HIV epidemic modeling techniques and incorporates evidence on biological transmission probabilities, detailed infection progression, sexual mixing patterns and drug injection behaviors. Data relating to programs and costs associated with programs are used in an integrated analysis to determine an optimized distribution of investment under defined scenarios.

Data from the Global Fund concept note, bio-behavioral surveys, and clinic registries were supplemented with published data and information from national registers to populate the Optima model. The model was then used to project the likely trajectory of the HIV epidemic in FYR Macedonia and to suggest how the epidemic may best be contained and treated with available financial resources. Optima is calibrated to HIV prevalence data points available from the different sub-populations (e.g., FSW, MSW, PWID, MSM), at specific time points, as well as to data points on the number of people on ART, and data surrounding registered PLHIV. This was performed in consultation with experts on the country's epidemic. Section 2 and Appendix 2 provide further details regarding the calibration process.

To assess how incremental changes in spending affect HIV epidemics and thus determine the optimized funding allocation, the model parameterizes relationships between the cost of HIV intervention programs, the coverage level attained by these programs and the resulting outcomes. These relationships are specific to the country, population and program being considered. Using the relationships between cost, coverage and outcome—in combination with Optima's epidemic module—it is possible to calculate how incremental changes in funding allocated to each program, will impact overall epidemic outcomes. Furthermore, by using a mathematical optimization algorithm, Optima is able to determine the "optimal" allocation of funding across different HIV programs.

2.2 Analytical framework

To tailor the model to a given context, analysts selected a number of parameters that describe the country population, levels of expenditure, programs to be included or excluded, time frames and the baseline scenario. The parameters appropriate to the FYR Macedonian context are listed in Table 2.1.

Table 2.1 Modeling parameterization

Category	Parameterization in the Optima model	Description/ assumptions
Populations defined in the model	1. Female sex workers 2. Clients of female sex workers 3. Male sex workers 4. Men who have sex with men 5. People who inject drugs 6. Males 15+ years 7. Females 15+ years	1. Females, aged 15+ 2. Males, aged 15-49 3. Males, aged 15+ 4. Males, aged 15+ 5. Males, aged 15+ 6. Males 15+ years excluding MSM, clients of FSW, MSW and PWID in this age group 7. Females 15+ years excluding FSW in this age group
Program expenditure areas defined in the model and included in optimization analysis[31]	1. Programs for female sex workers MSW (package) 2. Programs for men who have sex with men (package) 3. Opiate substitution therapy32 4. Needle-syringe program (NSP) and other prevention for PWID (package) 5. HIV testing and counseling 6. Antiretroviral therapy	1. Condom, lubricant distribution and information, education communication (IEC) material for HIV/AIDS preventative activities. Provision of medical and legal services as well as hygiene materials. 2. Condom, lubricant distribution and information, education communication (IEC) material for HIV/AIDS preventive activities. Peer education and outreach activities are also provided. 3. Provision of medication and related counseling. 4. Needle and syringe exchange, condom, lubricant distribution and information, education communication (IEC) material for HIV/AIDS preventive activities. Medical, social and legal services were also provided. 5. HIV test kits and pre- and post-testing counseling for all key population groups[33] 6. Antiretroviral drugs, related laboratory monitoring and clinical visits

[31] "HIV testing and counseling" and "ART" programs include services for key populations

[32] Since OST has substantial benefits outside of HIV (as will be explained further in the "limitations of the analysis"), a constraint was establish by putting a limit of 0% reduction in OST budget allocation (i.e. not reduce the funding in all optimization analysis (analyses 1-4) in order to prevent the optimized budget allocation from removing or reducing allocations to OST.

[33] In 2013, 87% of spending for HTC was on key affected populations.

Table 2.1 Modeling parameterization *(continued)*

Category	Parameterization in the Optima model	Description/ assumptions
Expenditure areas not included in mathematical optimization—indirect programs[34]	▪ Management, HR and training ▪ Enabling environment, ▪ STI control ▪ Monitoring, evaluation, surveillance, and research ▪ Health infrastructure ▪ Other costs ▪ Care and support for PLHIV ▪ Blood safety	'Enabling environment' includes legal and regulatory frameworks 'Other costs' include spending on following NASA items: ,prevention activities not disaggregated', ,risk-reduction for vulnerable and accessible populations', and ,HIV care') 'Care and support for PLHIV' includes social protection, cash transfer spending)
Time frames for optimization analysis	▪ 2000 – starting year for data entry ▪ 2017–21 (government's timeline for achieving new national HIV strategic plan targets) ▪ 2020 (interim timeline for international targets) ▪ 2030 (new UNAIDS horizon for ending AIDS)	
Baseline year for funding	2013 Global AIDS Response Progress Report values	

Source: Prepared by authors based on discussions with national experts.

2.3 Calibration

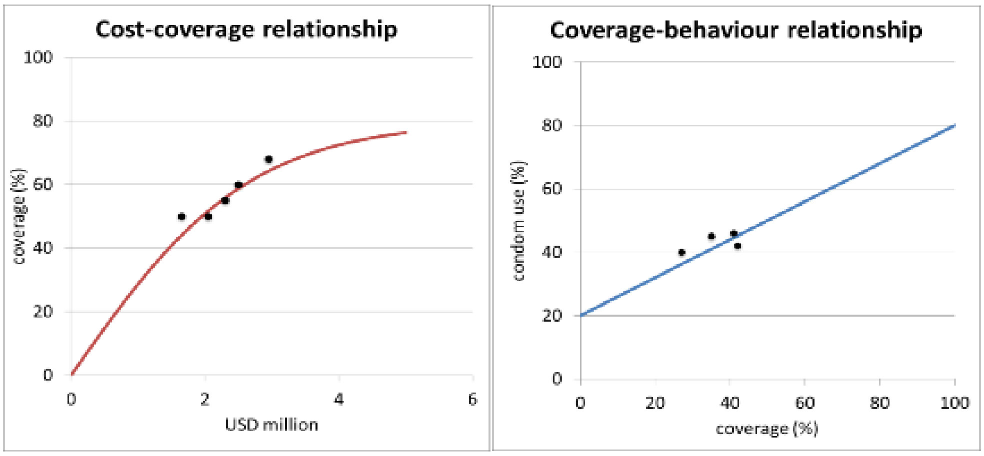
A key stage in the Optima modeling process is a stage known as 'calibration'. Calibration represents a model validation process in which Optima-projected trends are aligned with the historically observed trends in HIV prevalence in different population groups in a given context. Given the challenges inherent in fitting epidemiological and behavioral data, the calibration for FYR Macedonia was performed manually (i.e., by varying relevant model parameters in order to attain a best-fit between model-projected and historic HIV prevalence across different population cohorts). Where data was limited, these trends were compared with the registered new diagnoses. Once the Optima model is calibrated, it can project future expected trends in the HIV epidemic as described in Section 3.

2.4 Cost-coverage-outcome relationships

The relationship between program spending and coverage is shown in the left panel of Figure 2.1. This relationship describes the level of output achieved with a specific level of financial input. In the context of these analyses, output is defined as the availability of a service to a specific proportion of the target population. Coverage refers to the number of the population reached. For example, this relationship would describe how many MSM can be provided with a standard package of services with an investment of 0 to 1,000,000 USD. The relationship between coverage levels and outcome is shown in the right panel. This relationship describes the proportion of people who will adopt a specific behavior (such as condom use or consistent use of ARVs leading to viral suppression). These analyses were produced in collaboration with FYR Macedonian experts and the full set of figures can be seen in the Appendix 2.

34 Costs for indirect programs, also called enablers and synergies, have not been optimized but instead were fixed at agreed amounts (as they do not have measurable epidemic impact or because the expenditure is central systems expenditure that is essential for several program areas). Spending on Hepatitis C was removed from the analysis.

Figure 2.1 Logistic cost-outcome relationships for FYR Macedonia



Source: Prepared by University of New South Wales (UNSW) study team.[35]

The cost-coverage-outcome relationships are utilized, together with the calibration projections, to run the optimization and scenario analyses described in Sections 5, 6, 7 and 8.

2.5 Allocative Efficiency Analysis

Efficiency analyses must be informed by local priorities. FYR Macedonia is currently drafting a new national HIV strategy for 2017-2021. Based on the strategy for 2012–16, the primary aim is to maintain low HIV prevalence levels in FYR Macedonia[36]. This is to be achieved via a universal approach including prevention, treatment, care and support services - all based on upholding human rights and non-discrimination.

To support these national priorities and assist FYR Macedonia in the context of sustainability planning, this report will answer the following five questions: 1) What is the trajectory of the epidemic under different scenarios, in comparison to the currently predicted epidemic trends under the current HIV response? 2) How can FYR Macedonia optimize the allocation of HIV funding, and how close will the country get to minimizing new HIV infections and HIV-related deaths? 3) With changes to HIV budget allocation, how can FYR Macedonia optimize the allocation of HIV funding, and how close will the country get to minimizing new HIV infections and HIV-related deaths? 4) What is the minimum spend required to achieve possible National Strategic Plan targets if resources are allocated optimally? 5) How much funding is required to achieve National Strategic Plan targets if resources are allocated optimally?

Each of these questions is the subject of an analytical module as described in more detail below.

Analysis 1: What is the trajectory of the epidemic under different scenarios, in comparison to the currently predicted epidemic trends under the current HIV response?

This analysis compares the trajectory of the epidemic and key outcomes under the current allocation of resources (section 3) with different scenarios (section 5). These include:

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[35] The black dots represent available spending and coverage data as well as associated behaviors. The solid curves are the best fitting or assumed relationships.

[36] Macedonia, FYR. 2012. National HIV Strategic Plan 2012-2016.

1. Test and treat: In this scenario it was assumed that by 2020, 90% of PLHIV will be aware of their status and 90% of diagnosed PLHIV will be on ART[37].
2. Attaining global targets for all key populations: In this scenario, the trajectory of the HIV epidemic is assessed if the country aims for reaching global goals for all key populations.
3. Defunding all preventive programs: In this scenario, possible impacts of defunding all prevention programs for the key populations (including HTC programs) is explored.

This scenario analysis explores different levels of achievement of program outcomes. In this section we analyzed the epidemic impact if specific outcome levels or targets are achieved, regardless of cost and coverage considerations.

Analysis 2: How can FYR Macedonia optimize the allocation of HIV funding, and how close will the country get to minimizing new HIV infections and HIV-related deaths?

This analysis compares the trajectory of the epidemic and key outcomes under the current allocation of resources, against an optimized allocation of resources. For the purposes of this analysis, funding remains at current levels and is not varied. Only the way that funding is spent changes. The aim is to determine how FYR Macedonia might better allocate available resources to achieve maximum impact, and how close that maximum impact will be to possible National HIV Strategic Plan targets.

This analysis asks the following specific question:

- If funding is kept at the same level but resources are allocated differently, what then will be the expected annual levels of HIV incidence, HIV prevalence, and AIDS-related deaths? The results of this analysis are described in Section 6.

Analysis 3: With changes to HIV budget allocation, how can FYR Macedonia optimize the allocation of HIV funding, and how close will the country get to minimizing new HIV infections and HIV-related deaths?

This analysis explores the likely outcomes of potential decreases or increases in the available budget. The previous analyses assumed fixed amounts of available funding and explored an optimized allocation of those funds, to see what reductions in deaths and new infections could be achieved with the current budget. In contrast, this analysis aims for the maximum possible reduction of new deaths and infections under different budget envelopes (i.e., 50%, 75%, 90%, 110%, 125%, 150% and 200% of current funding), with allocations optimized. The results of this analysis are presented in Section 7.

Analysis 4: What is the minimum spend required to achieve possible National Strategic Plan targets if resources are allocated optimally?

This analysis identifies the minimum resource requirements to achieve possible national strategy targets. As the new national HIV strategic plan targets have not yet been identified, analyses were run to establish how much funding is required to a) maintain current outcomes and b) to reduce new infections and deaths by 50%? The results of these analyses are presented in Section 8.

Analysis 5: What are the long-term financial commitments to the HIV response?

This analysis reviews the impact of current investment choices on long-term financial commitments. Specifically, this analysis compares the commitments one would expect to

[37] Treatment efficacy in reducing new infections for PLHIV on ART was assumed to be 70 %.

result from the current allocation of the 2013 budget, against the optimized allocation of the 2013 budget described in Section 6. The findings from this analysis are presented in Section 9.

2.6 Limitations of the analysis

All mathematical models have their strengths and limitations. Results should therefore be interpreted with the necessary caution. In particular, it is important to note that:

- All model forecasts are subject to uncertainty. Therefore, point-estimates are indicative of trends rather than exact figures. This limitation is highlighted particularly in the context of FYR Macedonia, where the low level epidemic results in small population sizes and greater uncertainty in the model estimates.
- The model calibration depends as much on the quality of input data as on the quality of the model itself. The country and study teams have done everything possible to ensure the best possible data quality but it is never possible to have a complete, or completely certain dataset. The best model calibration will rarely achieve an exact match of historical data, but will mirror as closely as possible the key trends of them.
- There were some data gaps in FYR Macedonia. Missing data are most common for the general population and for clients of sex workers. Estimates of HIV prevalence in the general population were derived from registered cases amongst the heterosexual population. There was no data available for clients of sex workers. Therefore an assumed population size of 10% of the general adult male population (15–49 age group) was used and HIV prevalence amongst the client population was assumed to be ten times lower than HIV prevalence amongst FSW.
- The modeling approach used to calculate relative cost-effectiveness between programs includes assumptions about the impact of increases or decreases in availability of 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, assuming that there would be some saturation in the possible effect of programs with increases in spending.
- The cost-coverage-outcome relationships were derived from actual cost and coverage values for 2013.
- The analysis presented in this report does not determine the technical efficiency of programs as this was beyond the scope of the analysis. However, gains in technical efficiency may lead to lower unit costs and would therefore affect the optimized resource allocation described in this report.
- Modeling the optimization of allocative efficiencies depends critically on the availability of evidence-based parameter estimates of the effectiveness and cost-efficiency of individual interventions. Interventions/programs for which these parameter estimates do not exist, such as for many of the critical enablers, will be excluded for the mathematical optimization analysis. However, this does not mean that these programs should not receive funding. In addition, there are uncertainties around parameter estimates of some of the critical clinical interventions (e.g., ART and the parameter estimates such as the preventive effect of ART), which may distort the results.
- Effects of the programs outside the HIV endpoints including, for example, the wider health and non-health benefits of OST (beyond those directly related to HIV) and the effects of needle exchange programs on Hepatitis, are not included in this model. Given that, in the case of OST, there are significant benefits beyond HIV outcomes, the optimized budget

allocation was prevented from removing or reducing allocations to OST, by putting a limit on reduction in OST budget allocation.

- Along the same lines, the Optima modeling approach does not seek to quantify the human rights, stigma and discrimination, ethical, legal or psychosocial implications of providing or withdrawing care. The authors acknowledge that these are important aspects to consider.
- Other models may produce different projections than those produced by Optima. This is an underlying property when using theoretical mathematical frameworks. Different designs of the framework may generate different outcome projections. The analyses presented in this report have made use of the best available country data, experience gained from applying the Optima model in over 20 countries, and comparisons within the ECA region for the validation and contextualization of inputs and findings wherever possible.

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

In this section, the modeled projections of the HIV epidemic are described. These results are based on the calibration process and assume that current (2013) spending levels are maintained. Further calibration results are provided in the Appendix.

3.1 Current situation of the epidemic

The HIV epidemic in FYR Macedonia is a concentrated epidemic with 236 people diagnosed with HIV and 75 registered AIDS deaths cumulatively recorded by 1 December 2014[38]. As previously mentioned, there has been an increase in number of new infections, especially in the previous year. MSM make up 64% of newly diagnosed HIV infections. Input data on population size and HIV prevalence for key populations at higher risk of HIV exposure, are outlined in Table 3.1.

With current levels of funding and current allocations to HIV intervention programs maintained, the model projects that the epidemic will remain at a low level. However, the total number of PLHIV is projected to increase from a model-estimated 307 in 2014, to 438 by 2020 and 846 by 2030 (Figure 3.1). This increase is primarily a consequence of the expected increase in HIV incidence. As Figure 3.1 shows, 73% of PLHIV are projected to be MSM in 2020 and 78% in 2030. The same figure shows that PWID are likely to constitute 5% of all PLHIV in 2020 and 2% in 2030, while MSW are expected to constitute 5.1% of PLHIV in 2020 and 4.6% in 2030. Females in the general population are projected to comprise 11% of PLHIV in 2020 and 10% of PLHIV in 2030.

3.2 HIV prevalence is expected to increase

Overall HIV prevalence is projected to increase off a low base, from modeled-estimates of 0.018% in 2014 to 0.026% in 2020 and 0.050% by 2030 (**Figure A3**). The largest increases in HIV prevalence are projected to occur amongst MSW and MSM. In the MSW population, the model projects a steady increase in HIV prevalence from an estimated 3% in 2014 to 4% by 2020 and approximately 7% by 2030. On a similar trajectory, HIV prevalence amongst MSM is expected to increase from almost 2% in 2014 to just less than 3% by 2020 and approximately 6% by 2030. These projected figures are indicative only, as changes in risk behaviors, mobility or interactions with epidemics in neighboring countries may influence future HIV prevalence

38 Institute of Public Health of the Republic of Macedonia. 2015.

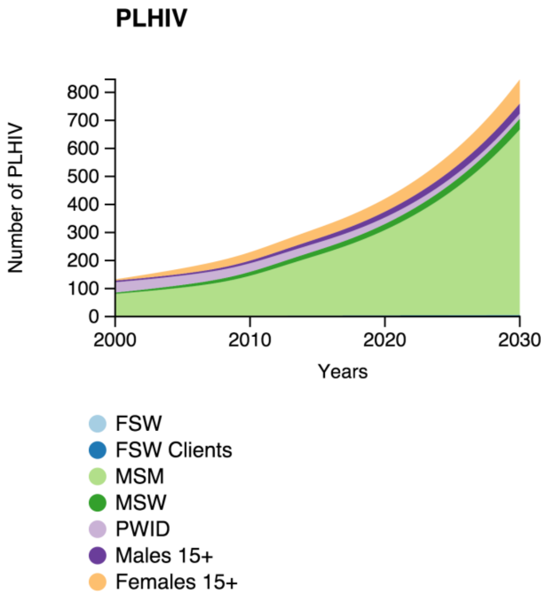
trends. Projections within small populations such as those in this context will always be more sensitive to small changes in risk factors than projections calculated for larger scale epidemics.

Table 3.1 Population size and prevalence among key populations

Population	Population size (most recent value)	HIV prevalence (most recent value)
FSW	2,136 (CI: 1,181–5,588)[39]	0.05% (estimate) [40]
FSW Clients	52,614 (estimate)	0.0052% (estimate)
MSM	19,300 (CI: 11,300–36,350)[41]	1.9%[42]
MSW	1,466 (CI: 810–3,835)[43,44]	3.43%[45]
PWID	11,532 (C.I. 9,782–14,632)[46]	0.123%[47]

Sources: Various as indicated in footnotes

Figure 3.1 Calibration of PLHIV



Source: Populated Optima model for FYR Macedonia.

[39] Size estimation based on, 'Kuzmanovska, Mikikj, Memeti, 2012. Report from the bio behavioural survey and assessment of population size of sex workers in Macedonia, 2010. Skopje: Institute for public heath of Republic of Macedonia.
Percentage of sex workers who are female, (59.3%) based on Mikik et al, 2014a. Report on the bio-behavioral study conducted among "male and female sex workers in Macedonia,"

[40] Mikik et al, 2014a estimated a 0.00% prevalence based on no diagnosed cases on HIV among FSW. However, it is plausible to assume that there is 1 case of HIV among this population which is 0.05%.

[41] Mikik, 2012. Report from the bio-behavioural study and assessment of population size of man having sex with man in Macedonia, 2010. Skopje: Institute for public health of Republic of Macedonia.

[42] Mikik et al, 2014b. Report on the bio-behavioral study among "men having sex, with men" population in Skopje, Macedonia, 2013-2014

[43] Size estimation based on, 'Kuzmanovska, et al. 2012.

[44] Percentage of sex workers who are male, (40.7%) based on Mikik et al, 2014a.

[45] Mikik et al, 2014b.

[46] Mikik et al.,2010. Report from the bio behavioural survey and assessment of population size of injecting drug users in Macedonia, 2010. Skopje: Institute for public heath of Republic of Macedonia.

[47] NGO testing data 2014. One diagnosed PLHIV out of 815 PWID tested.

HIV prevalence amongst FSW is projected to remain stable around 0.06%. It should be noted that, as the FSW population size is small, this translates into around two HIV positive female sex workers. As HIV prevalence amongst the client population is significantly influenced by HIV prevalence amongst FSW, there is also a very small increase in this population from 0.004% in 2014 to 0.005% in 2020 and 0.007% in 2030.

HIV prevalence amongst PWID is projected to decline slightly from an estimated prevalence of 0.24% in 2014, to 0.19% in 2020 and 0.16% by 2030. Using available data on HIV prevalence and behavior, Optima projects further reductions in HIV prevalence and incidence amongst PWID. This suggests that the country epidemic amongst PWID is under control, but the model does not account for changes in behavior or interactions with HIV epidemics amongst PWID in neighboring countries, which may negatively influence the epidemic trajectory.

Whilst HIV prevalence in the general population is very low, the model projects that there will be a steeper increase amongst adult females than amongst adult males. HIV prevalence in adult women is projected to increase from 0.004% in 2014 to 0.005% by 2020 and 0.01% by 2030. In contrast, the model predicted HIV prevalence amongst adult men is approximately half of that of women, increasing from 0.002% in 2014 to 0.003% by 2020 and 0.005% by 2030. This difference is likely explained by the fact that most men at high risk are included in the MSM, MSW, client and PWID populations—who in turn may infect their female sexual partners.

3.3 HIV Incidence is increasing

Underpinning the small increase in HIV prevalence described above, is a predicted increase in HIV incidence (**Figure A4**), mainly in the MSM population. The model predicts that, with the current allocation of funds, overall HIV incidence will increase from 0.002% to 0.006% between 2014 and 2030. New infections are projected to increase from an estimated 28 new infections per year in 2014 to 47 per year in 2020 and to have doubled by 2030, with an estimated 107 new infections per year (Figure 3.2). The majority of new HIV infections are predicted to be amongst MSM; from 64% of registered new cases in 2014, to a model estimated 78% of new infections in 2020 and 80% by 2030.

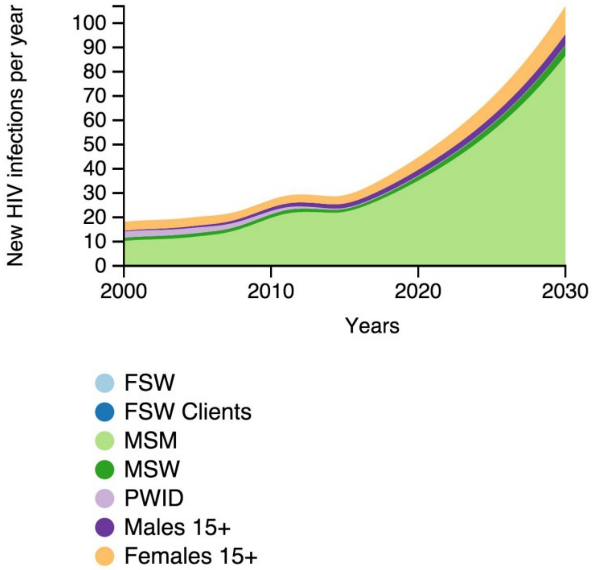
Much of the expected increase in HIV incidence is driven by the share of transmission attributed to unprotected sex between MSM and their partners. Low condom use of 46.8%[48] amongst MSM and casual partners is a particular concern, as is relatively low condom use with commercial partners i.e. 84% for MSW compared with 93% for FSW[49]. Therefore interactions between MSW and MSM remain important. Furthermore, 77% of MSM in the 2010 IBBS survey and 64.9% of MSM in the 2014 IBBS survey[50], reported having sex with a female in the past 12 months. The high probability of sex with female partners raises concerns about the potential role of MSM in 'bridging' HIV transmission to their sexual partners within the female adult population.

48 Mikik et al, 2014c.

49 Mikik et al, 2014a.

50 Mikik et al, 2014b.

Figure 3.2 Number of new HIV infections per year as per model calibration

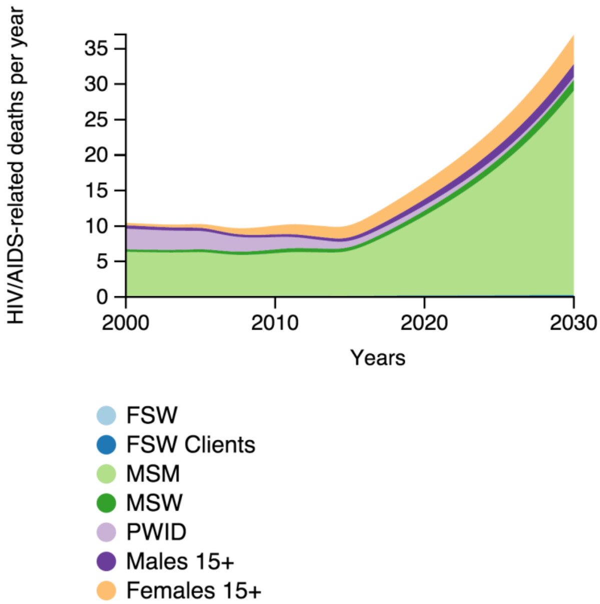


Source: Populated Optima model for FYR Macedonia.

3.4 AIDS-related deaths are low but predicted to increase

Until 2014, the number of AIDS-related deaths were estimated to have been relatively stable at 10 per year across all populations, reflecting the low-level epidemic of the 1990s. Overall however, the number of deaths attributable to HIV is predicted to increase to 17 in 2020 and 36 by 2030 if PLHIV are not diagnosed promptly and put onto treatment[51] (Figure 3.3). In addition to a projected increase in the estimated annual number of deaths (Figure 3.3), the model-estimated death rate i.e., the change in deaths over time, will also increase (Figure 3.4).

Figure 3.3 Calibration predicted number of deaths due to HIV in FYR Macedonia[52]

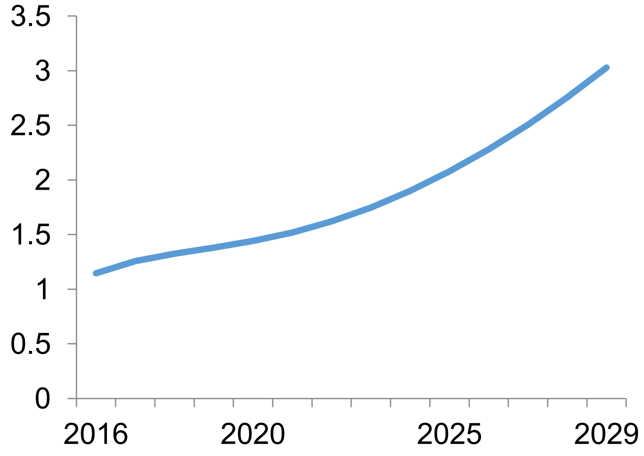


Source: Populated Optima model for FYR Macedonia.

51 Note that in calibration, the Optima model assumes that the number of PLHIV on ART remains constant.

52 This assumes stable behaviours and coverage of services.

Figure 3.4 Predicted death rate from 2016 to 2030



Source: Populated Optima model for FYR Macedonia.

3.5 The number of people requiring HIV treatment will increase

At the end of 2014, 96 people were receiving HIV treatment. However, with the predicted increase in new infections, demand for treatment will rise. Furthermore, at the time of the model analysis, FYR Macedonia only provided treatment when the CD4 count was less than 350cells/mm3. However, 2015 WHO guidance recommended commencing treatment for adults at any CD4 count[53]. If the FYR Macedonia is to adhere to international guidelines for HIV treatment, additional registered PLHIV will require treatment and more PLHIV may be newly diagnosed.

53 World Health Organization. 2015. Guideline on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV. Geneva (http://www.who.int/hiv/pub/guidelines/earlyrelease-arv/en/).

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4. WHAT IS THE IMPACT OF PAST AND CURRENT SPENDING?

4.1 Prevention receives the majority of current funding

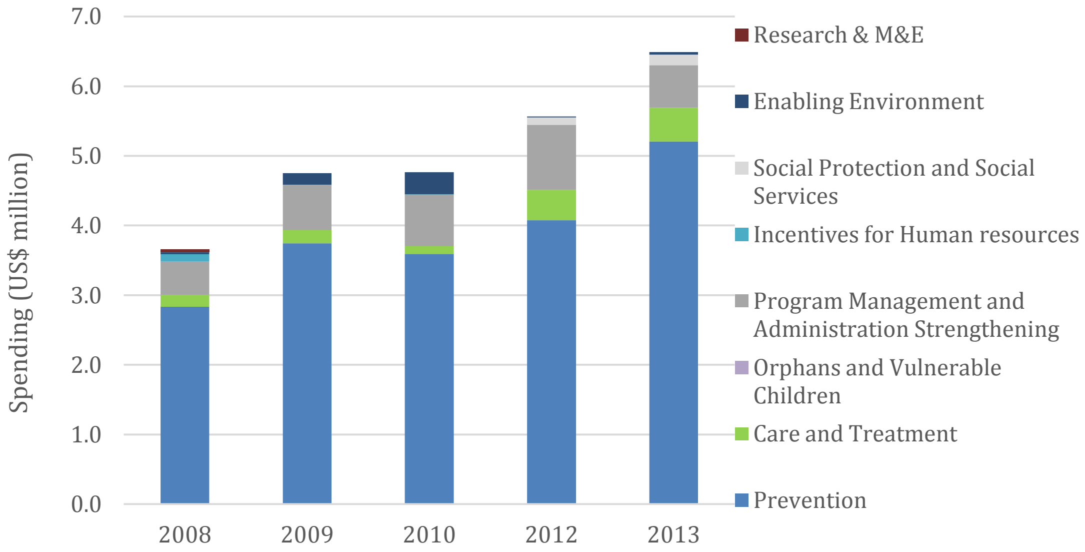
Prevention is the largest component of HIV spending in FYR Macedonia, at an average of 77% of total spending since 2008 (Figure 4.1). Within prevention, the largest share of spending has been on interventions targeting PWID, including OST, NSP and Hepatitis C prevention. Since 2008, interventions targeting PWID comprise on average 61% of prevention spending. In 2013, 63% of prevention spending and 51% of total HIV spending was allocated to harm reduction programs.

In contrast to PWID interventions, investment in other preventive programs targeting the general population or other key populations such as MSM and SWs, has been relatively low. These investments have also varied substantially over time, suggesting a fragile financing climate for individual programs. In 2013, targeted programs for MSM, SWs and the general population SBCC program were allocated 3%, 4% and 8% of prevention funding, respectively.

By comparison, HIV care and treatment spending constituted 7% of total spending in 2013. Spending on ART is funded entirely by public sources with approximately 50% of ART costs being met by the Health Insurance Fund, and the remainder by other resources from the National Ministry of Health. Specifically, ARVs and key monitoring tests (i.e. viral load and CD4 count) are funded by the Ministry of Health through the National HIV Program, whereas other spending related to treatment and medical care are funded by the Health Insurance Fund. Spending on ART has increased by approximately 76% since 2008.

Program management, the main indirect cost category in this context, has constituted an average of 14% of total HIV spending since 2008. Although this proportion was reduced to 9% in 2013, this proportion remains higher than spending on HIV care and treatment spending.

Figure 4.1 HIV expenditure in FYR Macedonia by type of spending

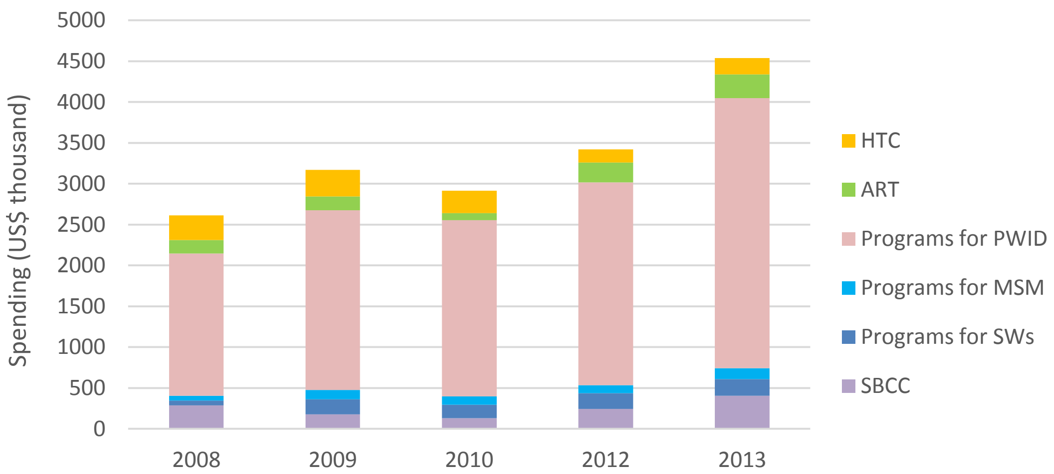


Source: Ministry of Health. 2014. National HIV/AIDS Spending report 2008–13.

4.2 Investment could be better targeted within and between key populations

Current investments in HIV prevention and treatment may not be benefiting those most in need (Figure 4.2). Model-based estimates suggest that, with exception of PWID, incidence and prevalence are increasing among key high-risk populations and MSM in particular. This suggests that prevention could be better targeted. If the potential role of MSM in 'bridging' the epidemic between MSW and general population women is further considered, then the case for better-targeted prevention is compelling as it is likely to yield benefits for both high- and low-risk populations. Current investment in prevention programs targeting MSM is low, as described previously.

Figure 4.2 Trends in spending across key priority prevention and treatment programs



Source: Ministry of Health. 2014. National HIV/AIDS Spending report 2008–13.

Although the prevalence and incidence of HIV amongst PWID has been decreasing and may decrease further or remain stable at a low level, the analyses suggest that there remains a need to invest in programs for PWID, including needle-syringe programs (NSP) and opiate substitution therapy (OST). Past investment in these programs have contributed substantially to the downward trend of the HIV epidemic in this population and projections are based on the continuation of current programs.

Using the cost-coverage relationships, the cost per person reached at 2013 spending levels were estimated. This basic analysis demonstrates that costs for many programs, in particular ART and OST, are high when compared with data for other comparable countries in the region (Table 4.1).

A more detailed review of unit costs and a targeted technical efficiency analysis may identify ways of reducing average OST, NSP and other costs - resulting in substantial savings to the overall budget. If high unit costs are reduced, without compromising the quality of programs, then an efficiency gain is achieved and 'saved' resources can be more effectively used to combat the epidemic through reallocation to other programs.

Table 4.1 Comparing cost per person reached in FYR Macedonia with other countries in the ECA Region[54]

Cost per person reached	FYR Macedonia, 2013	Comparison to other countries			
		Lowest	Highest	Average	Median
SW programs	203.39	41.66	203.39	117.29	107.05
MSM programs	48.96	23.67	449.13	133.66	48.96
PWID-NSP programs	174.51	40.90	174.51	99.09	101.36
OST	1054.26	431.41	1,645.24	880.19	935.15
ART	3835.43	576.48	3,835.43	1,509.50	1,195.70

Source: Populated Optima data spreadsheets from 7 countries.

While the data in Table 4.1 may identify the potential for technical efficiency savings, a number of cautions in interpreting these data should be noted. In particular:

1. Although all expenditure data has been extracted from NASA/GARPR reports, which follow a standard methodology, individual countries may not have classified all costs in the same way.
2. Coverage definitions and packages for each program may differ between countries. For example, in FYR Macedonia, HTC programs mainly cover testing for key populations and testing was not included in the program packages for the key populations.

Consequently, this table does not provide substantive information about which countries deliver services more efficiently. Instead, this analysis seeks only to highlight which programs may benefit from a further, more robust review of the potential for technical efficiency gains.

54 Note: Table 4 reflects how costs were categorized by countries for this analysis. The method is not based on detailed matching of classification of inputs, but on how countries had actually 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 regarding cross-cutting costs such as HR costs. In addition, even if costs are classified consistently, the comprehensiveness of service packages may differ. The completed Optima data matrixes for 7 ECA countries (including Georgia, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, and Ukraine) were compiled by the study team from a range of country-specific data sources during 2014–15. These data are based primarily on coverage data from program records for 2013/2014 and total HIV spending for a program area per 2013/2014 GARPR and NASA reports.

4.3 Current HIV investment averts infections and deaths

Model–based projections of the epidemic demonstrate that current spending on HIV prevention and treatment programs will continue to avert new infections and deaths. In the absence of any spending on the HIV epidemic, the model estimates that 97 more deaths would occur and 539 more people would be infected by 2030 (Figure 4.3). Furthermore, under a 'no spending' condition, the total number of PLHIV is projected to increase to 1329 by 2030, an increase of 30% compared with the epidemic trajectory under current spending. This highlights the need to continue investing in an HIV response.

Figure 13 Model-estimated impact of current spending compared to no spending on the HIV response, 2016–30.

Figure 4.3 Model-estimated impact of current spending compared to no spending on the HIV response, 2016–30[55].

Figure 4.3A Cumulative deaths

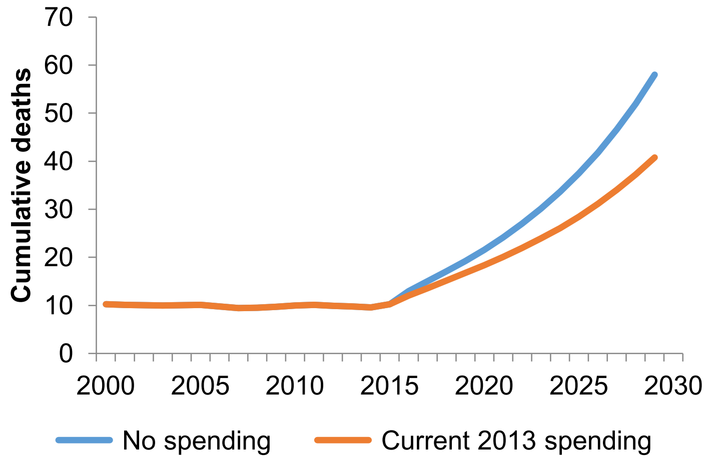
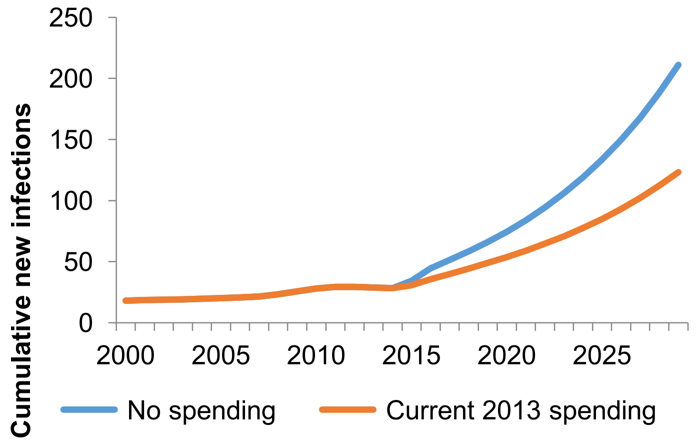


Figure 4.3B Cumulative new HIV infections



Source: Populated Optima model for FYR Macedonia.

55 'No spending' assumes that there is no spending on the HIV response. 'Current spending' assumes that current funding levels and allocations remain stable and achieve coverage in line with the cost-coverage-outcome curves defined in the model.

5. PREDICTING THE TRAJECTORY OF THE HIV EPIDEMIC: COMPARING HIV RESPONSE SCENARIOS

In the previous section, we compared current spending levels and allocations, against a 'no spending' scenario. Figure 4.3 demonstrated that the current response to the epidemic is significantly reducing HIV incidence and HIV-related mortality from the levels one would expect in the absence of interventions. The Optima model predicts that this positive impact is likely to persist, and even grow, in the time period to 2030. In this section, we ask whether reaching pre-specified targets regardless of the budget required, could potentially reduce HIV prevalence, new infections and AIDS related mortality further. Here we compare the trajectory of the HIV epidemic by 2030 in FYR Macedonia under the current HIV response against three alternative response scenarios that are not constrained by a budget but are determined solely by targets. These scenarios were identified through consultation with local stakeholders and a range of experts. The epidemic trajectory is predicted for each of these scenarios and compared with the trajectory under current programs, without determining the overall budget envelope required to achieve defined targets in each scenario.

The three response scenarios used for comparison were:

1. Test and offer treatment: In this scenario it is assumed that by 2020, 90% of PLHIV will be aware of their status and 90% of diagnosed PLHIV will be on ART[56]
2. Attaining global targets for all key populations: In this scenario, the country aims to reach global goals for all key populations
3. Defunding all preventive programs: In this scenario, the possible impact of defunding all prevention programs for key populations, including HTC, are explored

Table 5.1 presents detailed information on parameters and targets specified in the alternative scenarios.

The model-predicted evolution of annual HIV prevalence, new infections and deaths (2000–30) under these conditions are shown in Figures 5.1, 5.2 and 5.3. Figure 5.4 shows the expected HIV incidence amongst MSM for the same period for each scenario[57]. Overall, with the level and allocation of funding maintained as for 2013[58],HIV prevalence and the number of new infections and deaths are expected to increase. This is mainly driven by rising incidence amongst MSM, as described earlier.

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[56] Treatment efficacy in reducing new infections for PLHIV on ART was assumed to be 70%.

[57] The curve covering the historical period until 2015 in all scenarios is an output of the model calibration.

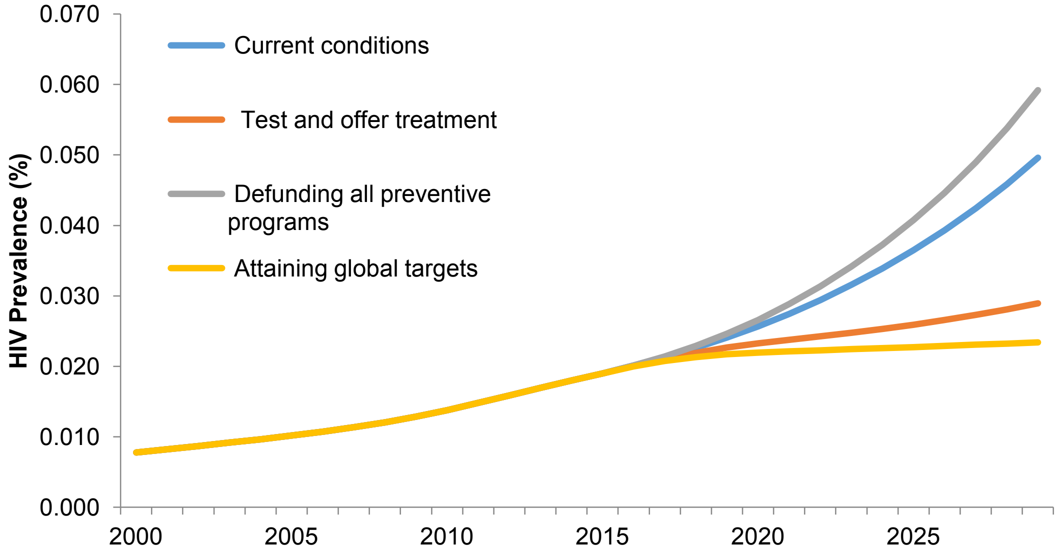
[58] An annual budget of $6,487,928 (including spending on Hepatitis C).

Table 5.1 Parameters and target values used in the alternative scenarios

		Alternative response scenarios*		
Target population	**Parameters**	**Test and offer treatment (Baseline–2020)**	**Attaining global targets (Baseline–2020)**	**Defunding all preventive programs (Baseline–2020)**
FSW	Proportion of sexual acts in which condoms are used with commercial partners	No change (93%)	93%-95%	93%–88%
	Proportion of people who are tested for HIV each year	N/A	N/A	44%–29%
Clients of sex workers	Proportion of sexual acts in which condoms are used with commercial partners	No change (91%)	91%–95%	N/A
MSM	Proportion of sexual acts in which condoms are used with casual partners	No change (47%)	47%–80%	47%–37%
	Proportion of sexual acts in which condoms are used with commercial partners	No change (84%)	84%–90%	N/A
	Proportion of people who are tested for HIV each year	N/A	N/A	19%–13%
MSW	Proportion of sexual acts in which condoms are used with casual partners	No change (71%)	71%–80%	
	Proportion of sexual acts in which condoms are used with commercial partners	No change (85%)	85%–90%	85%–80%
	Proportion of people who are tested for HIV each year	N/A	N/A	44%–29%
PWID	Proportion of people who are tested for HIV each year	N/A	N/A	33%–22%
	Proportion of injections using receptively shared needle syringes	No change (3.6% %)	No change (3.6% %)	3.6%–10.8%
Number of PLHIV on ART (all populations)		96–355 (2015–20)	96–355 (2015–20)	N/A
Proportion of people who are tested for HIV in each year (all populations)		35%–90% (2015–20)	35%–90% (2015–20)	N/A

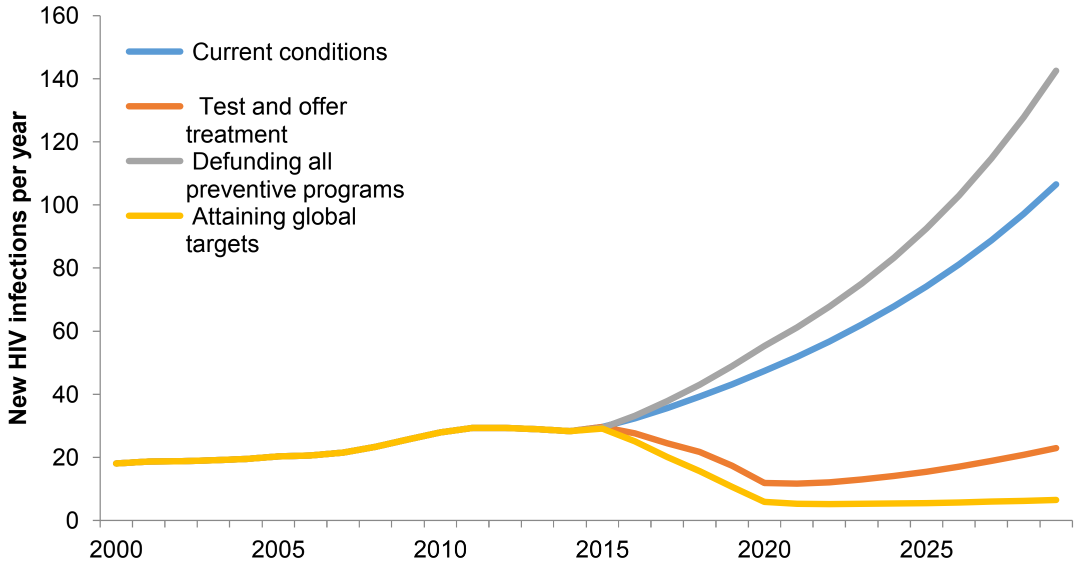
Note: * = Baseline data in each scenario are from different years when the latest data was available.
Source: Prepared by study team in consultation with national partners.

Figure 5.1 Model-predicted evolution of annual HIV prevalence under different scenarios (2000–30)



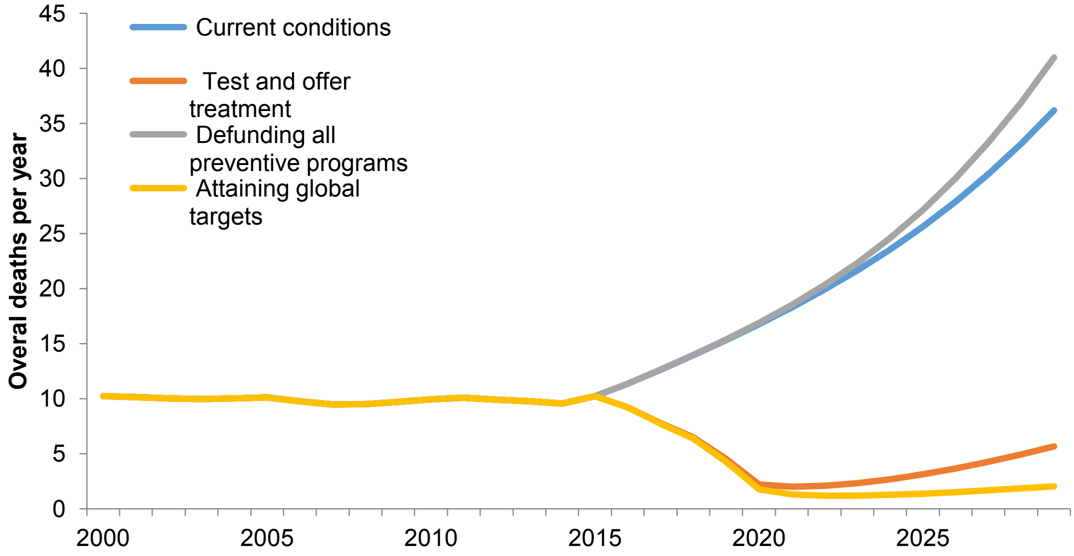
Source: Populated Optima model for FYR Macedonia.

Figure 5.2 Model-predicted evolution of annual new infections under different scenarios (2000–30)



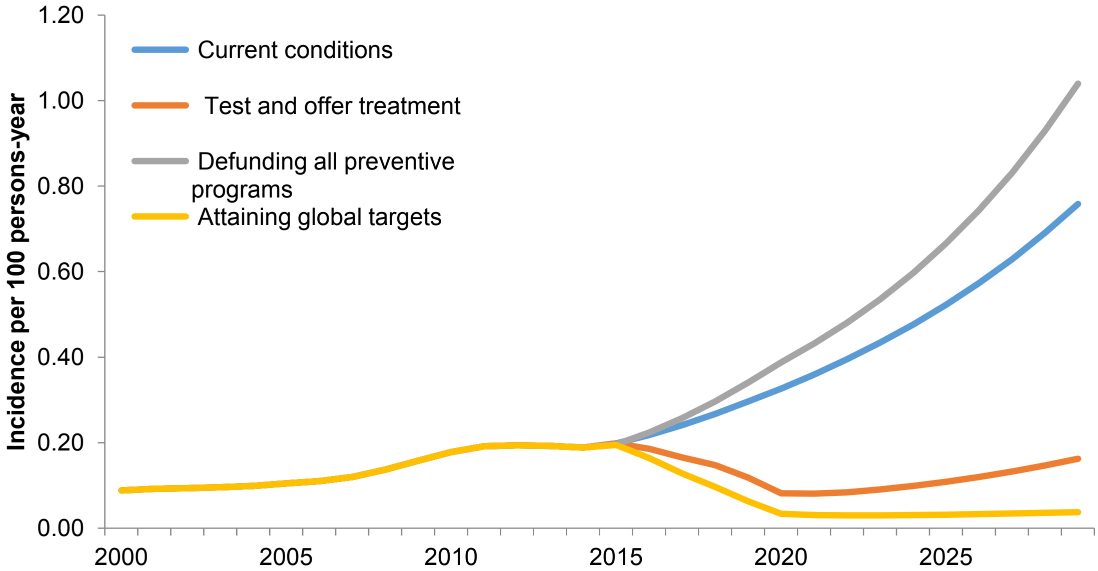
Source: Populated Optima model for FYR Macedonia.

Figure 5.3 Model-predicted evolution of annual HIV-related deaths under different scenarios (2000–30)



Source: Populated Optima model for FYR Macedonia.

Figure 5.4 Model-predicted incidence for MSM under different scenarios (2000–30)



Source: Populated Optima model for FYR Macedonia.

These analyses predict that *Scenario 1*, testing and offering treatment, will substantially reduce new infections and deaths compared with the current strategy. *Scenario 1* is estimated to result in 72% or 636 fewer infections, and 80% or 246 fewer deaths by 2030, compared with current conditions.

The findings also show however, that reaching global targets for all key populations (*Scenario2*), is even more effective in reducing the number of new infections and deaths than only testing and offering treatment (*Scenario1*). *Scenario 2* is projected to achieve an estimated 86% reduction in both new infections and deaths, with an estimated 757 fewer infections and 264 fewer deaths by 2030. The analysis shows that *Scenario 2* is also the most effective in reducing incidence amongst MSM, with an estimated reduction of 72% (Figure 5.4).

Findings from these analyses shows that defunding all prevention programs (*Scenario 3*) is expected to increase overall prevalence, the number of new infection and deaths by 9%, 19% and 5% respectively, compared with the current HIV response.

In reducing the number of deaths and new infections over time, *Scenarios 1 and* 2 are significantly more effective than the current HIV response. Therefore, whilst investment in key population groups remains key in the context of FYR Macedonia's concentrated epidemic, it remains essential to ensuring high treatment coverage for all PLHIV. It should be noted that in this section we analyzed the epidemic impact if specific outcome levels or targets are achieved, regardless of cost and coverage considerations. This approach is different from the optimization analysis in the next section, which is based on the cost-coverage outcome curves (CCOCs). In the optimization analysis presented next, we consider the effect of different levels of spending on programs, which then translate into coverage and outcomes according to the CCOCs.

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6. WHAT CAN BE IMPROVED BY OPTIMIZING THE ALLOCATION OF CURRENT FUNDING?

An optimization analysis was conducted comparing the allocation of the 2013 budget of $5,154,743[59] and an optimized allocation of the same budget for the time period 2015–30. This section presents the findings of this analysis.

Findings of model-based analyses suggested that the current distribution of funding is different from the model optimized allocation of the 2013 budget aiming to minimize both new infections and deaths (Figure 6.1 and Table 6.1). The optimized allocation of the 2013 budget averts an estimated 856 (85%) additional HIV infections predominantly among MSM, and 294 (87%) additional deaths between 2016 and 2030. To achieve these gains, the following key changes are proposed:

- **ART coverage should be increased to meet current need**
    - The analysis suggests that ART investment should be significantly increased from 5% to approximately 23% of the annual HIV budget (Figure 6.1 and Table 6.1), assuming all diagnosed PLHIV are eligible for ART. This high shift in spending reflects the relatively high effectiveness of ARVs as both treatment and prevention, since PLHIV on treatment have significantly reduced viral load resulting in reduced transmissibility. This intervention will reduce HIV incidence and prevalence across all key population groups. Where funding is diverted from programs that target these key groups, some of the optimized budget is 're-incorporated' here
- **HTC coverage amongst key populations should be increased**
    - ART cannot be scaled up unless HIV infections are diagnosed. It is therefore necessary to ensure that adequate funding is allocated to testing in key population groups. The model suggests an increase from an estimated 3.6% to 4.8% of the annual HIV budget
- **Investment in MSM programs should be increased**
    - The analysis suggests that investment in MSM programs should be substantially increased, from 2.4% to 6.2% of the annual HIV budget (Figure 6.1 and Table 6.1). The MSM population group makes up the highest number of PLHIV in the FYR Macedonian context and individuals from key populations such as MSM may infect partners in low-risk populations. Targeting key populations therefore has benefits for both high- and low-risk populations but constitutes a more efficient financial

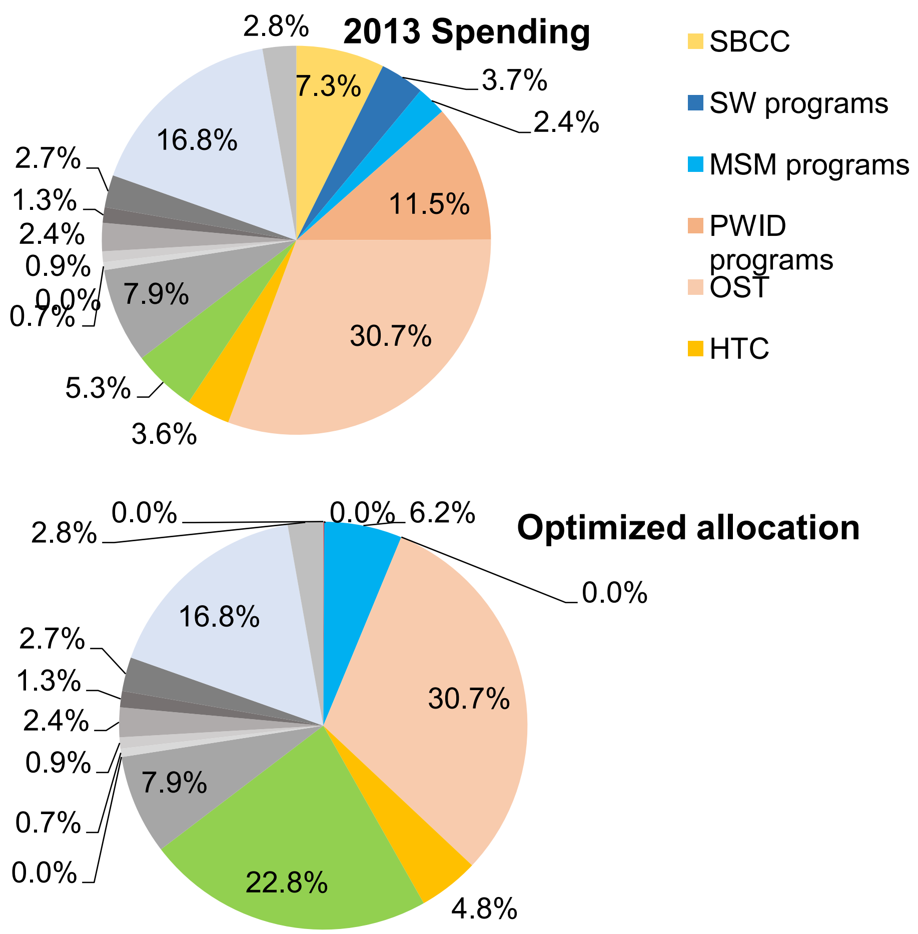
59 This figure does not include spending on Hepatitis C (around 1 $million). Moreover, only direct programs such as key population programs (FSW, MSM, PWID), ART, SBCC and HTC programs are included in the optimization analysis. The indirect programs or cost items such as program management, enabling environment, blood safety etc. were not included in the optimisation analysis.

investment. Since the epidemic in the low-risk, general population is too small to be self-sustaining without the increased risk from 'bridging' individuals in key, higher-risk populations, the most effective strategy is likely to be targeting new infections among key populations such as MSM

- **Coverage of PWID programs should be maintained, but cost-efficiency of programs should be reviewed.**
  - Low needle-sharing rates and a decreasing or stable HIV epidemic amongst PWID are at least partly attributable to the strong historical focus on this key population. These outcomes can only be sustained with sustained engagement
  - However, as the cost per person reached in this population appears higher than in other comparable countries, a review of these costs may be needed to maximize cost-efficiency and ensure the future sustainability of PWID programs
- **Coverage of SW programs should be maintained, but cost-efficiency of programs should be reviewed**
  - Under the optimized allocation, the 2013 budget for SW programs is reduced. This is due to the fact that the model only takes HIV-related economic considerations into account, and HIV prevalence amongst FSW is currently extremely low. However, the wider sexual and reproductive health needs of FSW remain critical and any suggestion to defund these programs should be treated with caution
  - SW programs aim also to target the MSW population, and this population group needs increased prioritization within sex worker programs
  - As with programs targeting PWID, the cost per person reached in this population appears higher than in other comparable countries, suggesting that a review of these costs may be needed to maximize cost-efficiency and ensure the future sustainability of SW programs
- **Investment should be shifted away from SBCC and programs targeted at the general population**
  - HIV prevalence among the low-risk, general population in FYR Macedonia is still very low and programs targeting this population are not effective or cost-effective compared with programs targeting key population groups
  - An optimized allocation suggests shifting resources from the low-risk general population, toward key population programs -especially MSM programs in the context of FYR Macedonia. This shift would benefit both the key population in question, and the low-risk, general population
- **Recommendations for OST spending should be interpreted with caution**
  - OST is defined by UNAIDS and the WHO as one of the essential service components for PWID HIV harm reduction programs. As described in Section 2, the Optima model considers only benefits to HIV patients and as such, service components such as OST that have significant wider benefits to the PWID population and to national public health, may be undervalued
  - OST has therefore been constrained in the model at 100% of 2013 spend, to ensure that this program is not defunded
  - Wider public health arguments, independent of the HIV discourse, suggest that OST should be sustained and expanded
  - Programs such as NSP are likely to have a significant preventive effect in HIV epidemics and not all PWID will access OST. OST is therefore not a replacement for NSP

The model suggests that allocating current funding differently, could further reduce the spread of the epidemic when compared to the current budget allocation. However, with a larger budget envelope it may be possible to avert additional new infections and deaths. The potential gains to increased investment in HIV programming, and effects of a decreased investment, are described further in the following section.

Figure 6.1 Comparison of current and optimized budget allocation to minimize both new infections and deaths for the period of 2015–30



Source: Populated Optima model for FYR Macedonia.

Table 6.1 Current and optimized 2013 budget allocations (in US$)

	Current allocation	%	Optimized allocation	%
SBCC	404,382	7.34%	1,106	0.02%
SW programs	202,985	3.68%	2,627	0.05%
MSM programs	134,733	2.44%	339,932	6.17%
PWID programs	632,949	11.49%	1,495	0.03%
OST	1,694,198	30.74%	1,694,198	30.74%
HTC	200,820	3.64%	264,716	4.80%
ART	291,493	5.29%	1,257,486	22.82%
MGMT	435,970	7.91%	435,970	7.91%
HR	0	0.00%	0	0.00%
ENV	36,168	0.66%	36,168	0.66%
M&E	49,233	0.89%	49,233	0.89%
INFR	129,559	2.35%	129,559	2.35%
STI	71,073	1.29%	71,073	1.29%
Support	148,400	2.69%	148,400	2.69%
Blood safety	924,750	16.78%	924,750	16.78%
Other	154,186	2.80%	154,186	2.80%
Total	**5,510,899**	**100%**	**5510899**	**100%**

Source: Populated Optima model for FYR Macedonia.

7. WHAT ARE THE LIKELY EFFECTS OF CHANGING HIV SPENDING AND ALLOCATION?

In this analysis, optimized allocations to programs and the corresponding impact are estimated and compared for different levels of funding. Specifically, this analysis considers what could be gained by increasing HIV spending from 2013 levels of provision. Conversely, the analysis also considers which programs would have the largest impact on the epidemic if less funding was available and the response needed to be further rationalized.

If 75% to 90% of 2013 funding is available, optimization analysis suggests that ART, OST and MSM programs should be given priority (see Figure 7.1). This finding is the result of a combination of factors. ART is essential to minimize deaths, while contributing also to reduced incidence. For further prevention, increasing condom use amongst MSM is an important behavioral strategy in the FYR Macedonian context. OST remains a priority as the model construct protects 100% of the funding for OST services. This is based on the rationale that nobody on OST should stop receiving treatment. Similarly, no one on ARV treatment would have treatment withdrawn. OST also has substantial benefits outside of HIV prevention, as explained in the remarks on the model in Section 2 and therefore all OST spending was protected in the optimized allocations. As OST funding is both protected and relatively expensive compared with some other prevention strategies, efforts should be made to ensure the high unit costs of OST are reduced as far as possible - without compromising the quality of care. Savings achieved through OST efficiency gains could be used to sustain other programs for PWID, in particular needle and syringe programs.

If 100% to 200% of 2013 funding is available, optimization suggests that investment should continue to be focused on ART and OST. Funding for MSM programs should also increase in this scenario. This analysis suggests that with a larger budget, a significant share of funding should be allocated to HTC programs for key populations. Spending on programs for the low-risk, general population (such as SBCC), are only recommended at higher multiples of the current budget i.e. when the optimized spending budget is approximately 200% of 2013 spending.

This analysis shows that increased and optimally allocated spending on HIV programs may continue to yield some gains in terms of infections and deaths averted (see Figure 7.1). However, the most substantial gains can be made in optimizing the allocation of the current budget (i.e., 2013 spending), with proportionately smaller gains made by increasing the current spend further.

It should be noted that the following figures present increases in spending for program budgets to 120%, 150% and 200% of 2013 levels respectively. These increases do not correspond to the same proportional increase in the total HIV response budget as it was

assumed that the indirect costs of management, infrastructure and other enabling factors would be stable. These indirect costs were therefore fixed within the HIV budget.

Figure 7.1 Optimized allocations to minimize HIV incidence and deaths by 2030 at different budget levels (2013 spending)

Figure 7.1A Average annual HIV spending 2016–30

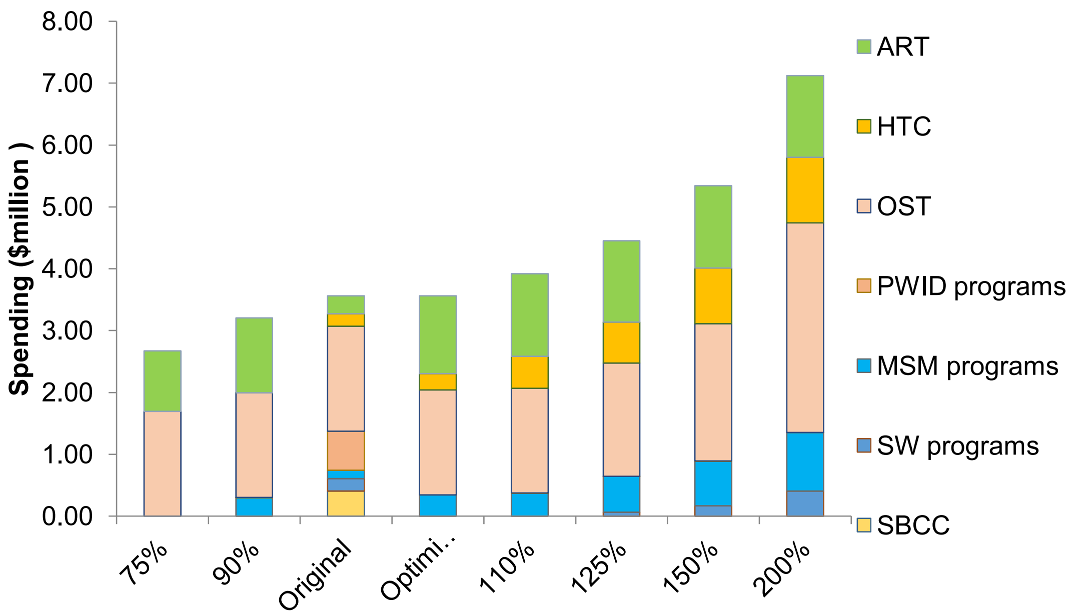


Figure 7.1B Average annual new HIV infections 2016–30

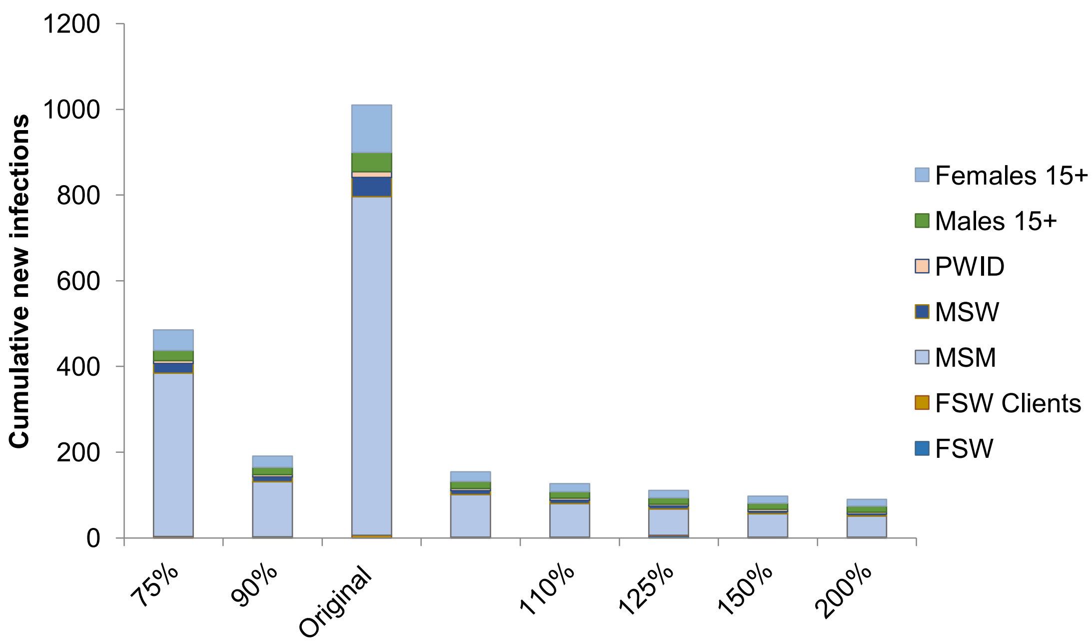
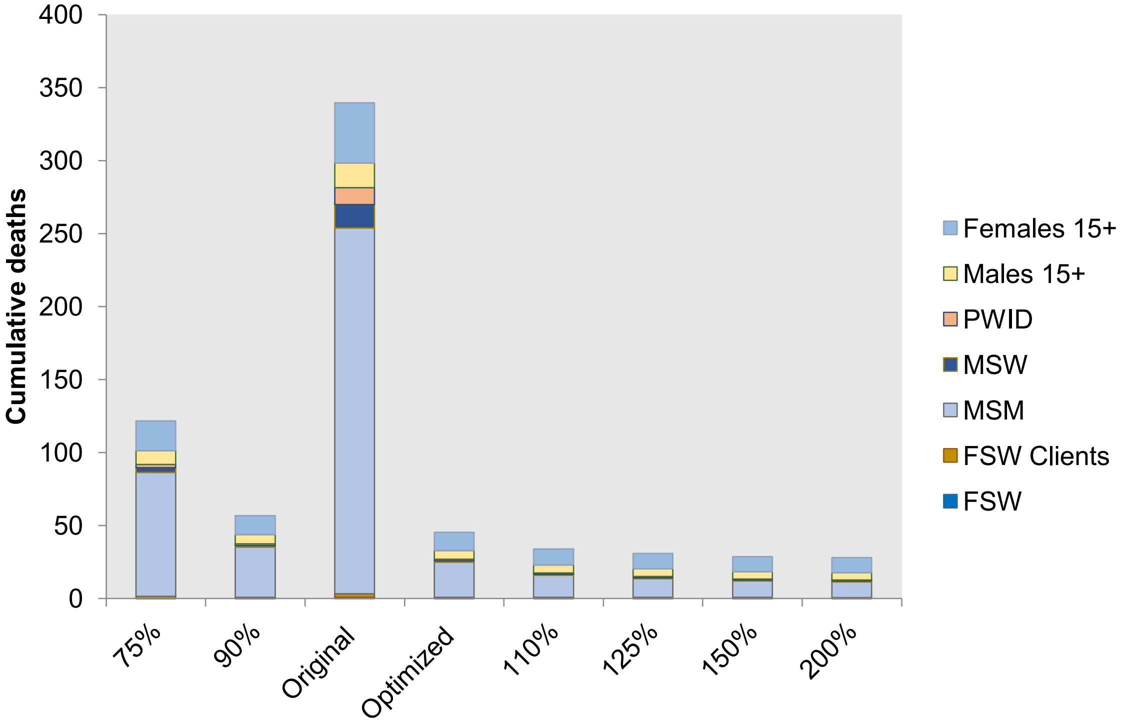


Figure 7.1C Average annual AIDS related deaths 2016–30



Sources: Populated Optima model for FYR Macedonia.

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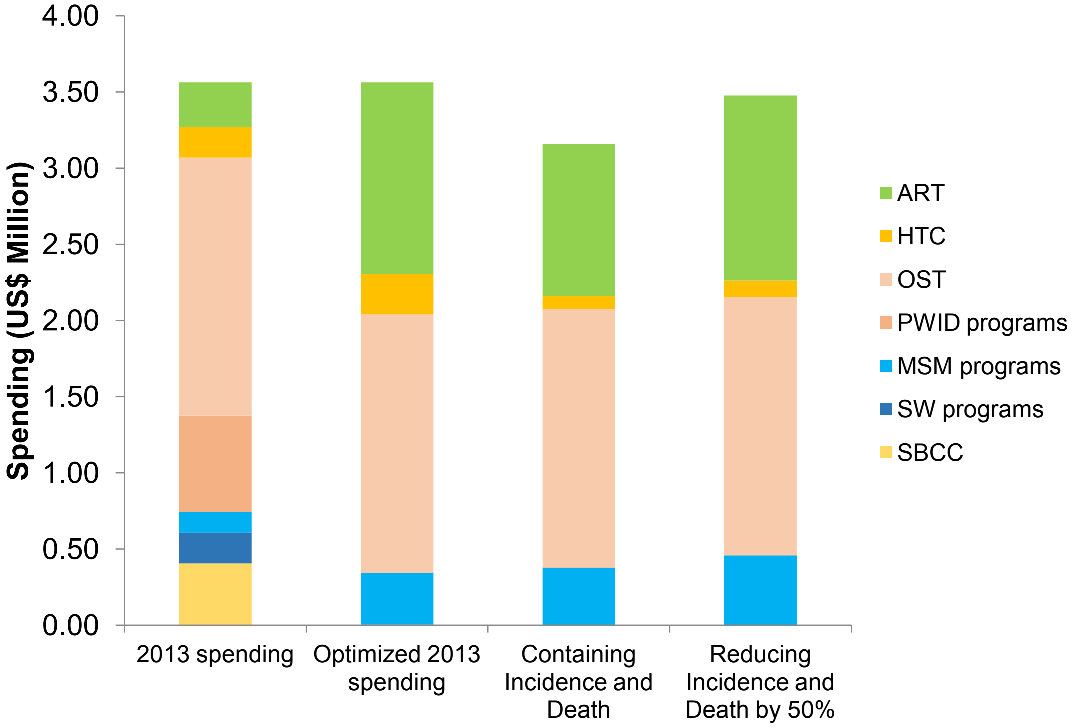
8. HOW MUCH WILL IT COST TO ACHIEVE PROPOSED NATIONAL HIV STRATEGIC PLAN TARGETS?

This analysis identifies the minimum annual resource requirements to achieve the proposed national strategy targets, as described in **Section 2**. The analyses in **Section 6** assumed a fixed amount of available funding and explored an optimized allocation of those funds to minimize new infections and deaths. In **Section 7**, the analyses explored the likely gains from increased investment in the HIV response. In contrast, the analyses in this section aim for the full achievement of possible national HIV strategic plan targets, and determine the minimum investment required to achieve those goals with an optimized allocation. As the final national HIV strategic plan targets have not yet been confirmed in FYR Macedonia, this analysis will assess the funding required to a) contain current incidence and death rates, and b) reduce new infections and deaths by 50%.

Figure 8.1 shows the current allocation of 2013 spending, the optimized allocation of 2013 spending and the minimum spending required, with an optimal allocation, to achieve the two targets described above. Benefits of optimizing the 2013 allocation are fully described in **Section 7**. The model results presented here suggest that $5.1 million would need to be invested annually to achieve the first target of maintaining current incidence and death values. This includes the programmatic spending shown in Figure 8.1 and the fixed indirect costs mentioned previously in **Section 7**. This total budget is slightly less than the 2013 budget of $5.5 million. Similarly, this analysis estimates that reducing of new infections and deaths by 50% could be achieved with annual spending of around $5.4 million, which is not significantly different to the 2013 budget.

These findings reinforce those of the previous section that the greatest efficiency gains can be achieved through better allocation of the current budget, after which gains to increasing the total budget are modest. In order to achieve both targets, the model findings recommend increased investments in ART and MSM programs: around three times more than the current spend to stabilize outcomes and around four times more to reduce incidence and deaths by 50%. This funding would be reallocated primarily from SBCC, PWID-NSP and SW programs.

Figure 8.1 Minimum annual spending required to meet selected targets

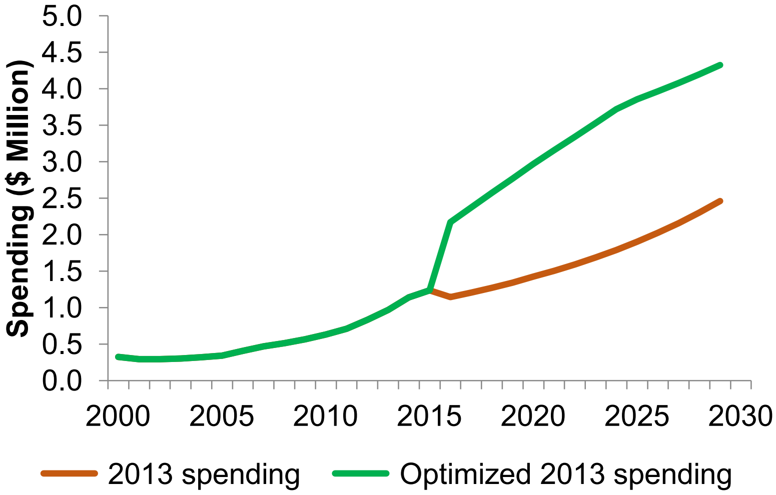


Source: Populated Optima model for FYR Macedonia.

9. WHAT ARE THE LONG-TERM FINANCIAL COMMITMENTS TO HIV SERVICES FOR PLHIV?

This analysis reviews the long-term impact of current and optimized investment choices, assuming the annual 2013 spend of $5.5 is maintained. Long-term impact refers to all long-term financial liabilities arising from the commitment to provide HIV and related health services to PLHIV in the future. In monetary terms, a financial commitment is the discounted cost of providing HIV services for PLHIV in a particular year. It includes HIV treatment costs, HIV related health care costs and social mitigation costs.

Figure 9.1 Annual HIV related spending for all old and new HIV infections up to 2030

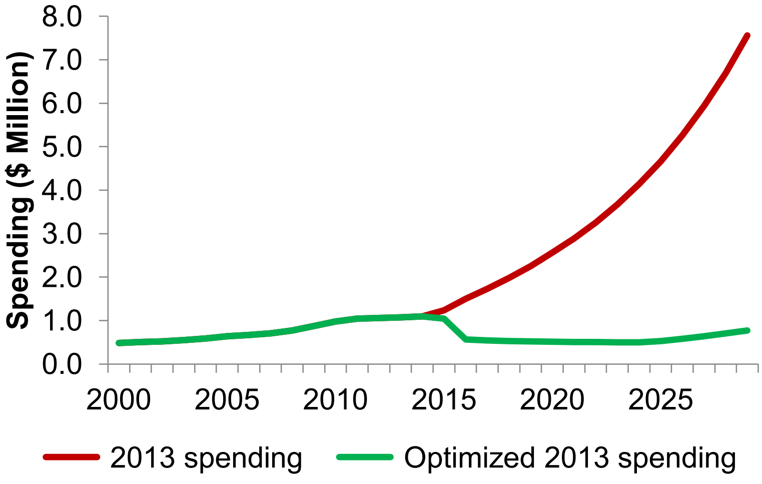


Source: Populated Optima model for FYR Macedonia.

Figure 9.1 describes the annual costs for HIV treatment and HIV-related care, derived from the expected number of PLHIV from 2016 to 2030. The current allocation of 2013 spending is compared with the optimized allocation described in Section 6. The results of the analysis predict that HIV response costs will rise gradually under both allocations, driven by the expected increase in the total number of PLHIV. The model estimates that optimizing current allocations will nearly double the cost of the annual HIV response compared to the current, non-optimized allocation. This is a result of the fact that the optimized allocation will increase uptake of ART and keep more PLHIV alive for longer through substantially increasing ART coverage, which is currently very low. This increases the total long-term cost of the response for all PLHIV. However, the model predicts that financial commitments caused by new infections each year i.e. life-time HIV care costs for newly diagnosed cases under the optimized allocation of current spending, will be 85% lower than under the

current allocation as shown in Figure 9.1. This is caused primarily by expected reductions in HIV incidence, resulting from optimized preventive programming.

Figure 9.2 Predicted life-time HIV care costs of new diagnosed cases in each year



Source: Populated Optima model for FYR Macedonia.

10. SUSTAINING AN EFFECTIVE HIV RESPONSE

Historically, the Global Fund was the primary source of funding for prevention and treatment programs in FYR Macedonia. Recently however, the National Ministry of Health took responsibility for the funding of some programs previously funded by the Global Fund - including the provision of Methadone for OST since 2008, and ART and supportive treatment for PLHIV since 2010[60]. However, as FYR Macedonia prepares for the full withdrawal of Global Fund support at the end of 2016, there remains a substantial funding gap that will need to be met if the current HIV response is to be sustained. This funding gap is most significant for prevention programs. This section uses the analyses described previously in this report, to highlight the specific challenges and recommendations for successful transition to national ownership of a sustained and effective HIV response.

10.1 Allocative efficiency gains should help FYR Macedonia 'do more with less'

The allocative efficiency gains described elsewhere in this report, should enable the Ministry of Health to achieve greater health impact with a sustained or slightly smaller HIV budget. Allocative efficiency gains in this context will primarily be achieved by increasing funding to programs targeted at prevention in key populations, reducing spending on prevention in the general population where the risk of new infections is low, and increasing spending on ART. Key populations to target include MSM and MSW. Scaling up ART delivery will benefit both key populations and the general population.

The National Ministry of Health currently finances ART and associated treatment from the Health Insurance Fund and other Ministry of Health resources as described earlier. As coverage expands, so too will the funding needs of this program. As the Health Insurance Fund currently only partly funds ART provision, the Ministry may seek to expand contributions from this source to meet or reduce the funding gap.

10.2 Technical efficiency gains could be further explored in future work

As mentioned previously, the unit costs of programs such as OST are higher in FYR Macedonia than in other comparable countries in the region. A thorough review of potential strategies to reduce costs, whilst maintaining the quantity and quality of service provision, should therefore be considered.

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60 CCM Request for Renewal from The Global Fund. May 2014

It is positive to note that drug prices for ARVs have reduced between 2014 and 2015. Further savings may also be achieved by exploring opportunities to switch from branded to generic drugs, moving towards single drug regimens where appropriate, engaging with pooled procurement schemes or changing the drugs prescribed to cheaper, equally effective alternatives.

As yet, no comparable reduction in OST costs has been observed. It may be important to note in this case that 16% of those on OST treatment in 2014 were on Buprenorphine. Buprenorphine is substantially more expensive then methadone, while studies from other settings found no difference in effectiveness[61,62]. As such, Buprenorphine may be less cost-effective[63] when compared with methadone and a change in the drug used may yield significant technical efficiency savings. Aside from any changing drug regimens, achieving further technical efficiency gains in drug pricing may be difficult for FYR Macedonia due to low economies of scale, but with increasing coverage enhanced price negotiations could be explored. Pooled procurement processes may warrant further exploration in this context, as suggested earlier.

In addition to high cost programs such as ART and OST, technical efficiency gains could also be considered for other prevention programs targeting key populations. This may require further collaboration between non-governmental organizations (NGOs) for providing preventive care, or further integration of HIV testing with other elements of the existing basic care package. There may also be scope for NGOs who support different key populations, to collaborate further to improve technical efficiency.

SW and MSM programs are almost entirely funded by the Global Fund and sourcing alternative funding for these programs remains critical. With the transition to national ownership, programs serving these populations may need to explore new co-funding opportunities and possible income generating activities. Service models may need to be reviewed when considering how to meet the needs of the epidemic after the transition from international to domestic funding. Mechanisms for the government to contract and manage NGOs need to be decided upon and developed.

Program management and administration, the main indirect cost category in this context, constituted 9% of total HIV spending in 2013. This is lower than some other countries in the region but it is higher than HIV care and treatment spending, which constituted 7% of total HIV spending in 2013. Although these indirect costs have been fixed in the analyses presented in this report—future work may explore opportunities to rationalize program management and administration costs, with the savings then allocated to the direct costs of the HIV response.

Finally, further analysis may explore whether HIV services could be further integrated into existing services. This includes STI, reproductive health, tuberculosis and other services. One of the strengths of the FYR Macedonia's HIV response is the coordination of its services

[61] Mattick R, Kimber J, Breen C, Davoli M. Buprenorphine maintenance versus placebo or methadone maintenance for opioid dependence. Cochrane Database Syst. Rev. 2003:CD002207.

[62] Gowing L, Ali R, White J. Buprenorphine for the management of opioid withdrawal. Cochrane Database Syst Rev. 2006:CD002025.

[63] Connock M, Juarez-Garcia A, Jowett S, Frew E, Liu Z, Taylor RJ, et al. Methadone and buprenorphine for the management of opioid dependence: a systematic review and economic evaluation (iii-iv). Health Technol Assess. 2007;11:1–171.

across service delivery modalities. This strength could potentially be harnessed further with better integration of services.

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11. CONCLUSIONS

1 **The FYR Macedonian government has implemented an effective HIV response to date, maintaining a very low level HIV epidemic. The FYR Macedonian government could allocate future HIV spending optimally to further minimize HIV incidence, prevalence and HIV-related deaths.**

2 To assess HIV epidemic trends, this report used Optima's epidemic module, calibrated to HIV prevalence data points available for different sub-populations in FYR Macedonia, including key populations. The model was also calibrated to data points for the number of people on ART from available data sources, and in consultation with FYR Macedonian experts. **Analyses using this model highlight a strong risk that prevalence and incidence will increase overall in FYR Macedonia, mainly amongst MSM, in spite of current efforts to contain the epidemic.**

3 **The expected overall increase in the epidemic appears to be driven by increasing incidence and prevalence among MSM, a key population that currently only receives a small portion of HIV funding**. High-risk behavior in this group, including low condom use, calls for significant strengthening of interventions targeting this population. Increasing the use of condoms with casual and commercial partners is likely to be an effective preventive measure. Additional programs such as Pre-exposure Prophylaxis (PrEP) may also be considered for MSM and MSW at highest risk, although current rates of HIV incidence are still substantially below 3 in 100 person years, which WHO has suggested as an indicative level for PrEP to be cost-effective. Only a very small subset of MSM and MSW might be at such high risk.

4 **Funding allocations that prioritize improved condom use, higher HIV testing rates among MSM and MSW, and scale up of ART to all populations in need - will be most effective in containing the epidemic overall.** An optimized allocation of current funding may increase longer-term financial commitments to the HIV response by increasing uptake of ART, but will substantially decrease financial commitments caused by new infections, which would decline with optimized allocations.

5 **Presentation for testing and treatment is currently delayed for some people living with HIV, thus increasing costs and reducing positive outcomes on treatment.** These delays are likely to be caused by multiple factors in the FYR Macedonian context, including possible fear of stigmatization and discrimination amongst MSM and MSW. These deterrents to effective care-seeking may add the additional risk of weak adherence to treatment. Risk factors such as these are best addressed with a rights-based approach to care.

6 These analyses suggested that **reallocating funding towards prevention amongst MSM and MSW, would improve the efficiency of current spending**. Our estimations and contextual data suggest that the HIV epidemic amongst PWID and FSW is relatively well contained in FYR Macedonia, due to significant and prolonged efforts to target these populations. However, due to the risk of rising HIV infection amongst PWID in the future as experienced in other countries of the region and due to the risk of transmission of other, more prevalent infectious diseases such as Hepatitis C, it i**s essential that coverage levels of NSP and OST are sustained.** It is also an important public health priority that the wider sexual and reproductive health needs of FSW continue to be met.

7 **Comparing the unit costs of care in FYR Macedonia, with data from other countries in the region, suggests that greater efficiency in spending might be achieved through strategies to reduce the average spend per person reached.** These strategies should not intentionally or unintentionally compromise the current quantity, quality or scope of prevention or treatment programs. Further analyses of technical efficiency are needed before more robust conclusions can be reached.

8 **Current annual spending should be sufficient to achieve potential national HIV strategic plan and international targets if optimally allocated**. By describing the likely trajectories of the HIV epidemic under different conditions, highlighting areas of particular risk in the short- to medium-term, and suggesting ways to incrementally improve the efficiency of current spending, these suggestions should assist FYR Macedonia in optimizing their current HIV response. Modeling the epidemic in the absence of HIV program spending highlighted the **significant gains already achieved from current spending in the form of new infections and deaths averted**. However, analyses of what is needed to achieve possible targets set by the National HIV Strategic Plan have identified the need for continued investment in an optimized HIV response in FYR Macedonia.

9 **Mapping of key populations will be essential in planning for scaling-up recommended programs. This is particularly true in the case of the MSM and MSW populations.** As the findings show, the number of new infections is increasing amongst the MSM population and it is important to increase coverage of MSM programs. The MSM population is a hard to reach group for a number of reasons, with a large proportion of this group remaining 'hidden.' Fear of stigmatization and discrimination may prevent affected individuals from accessing health services and undergoing testing – as demonstrated by the fact that only 19% of MSM had an HIV test in 2014[64]. This group is also not homogenous and many have female partners, while a significant proportion pay for commercial sex. Condom use also varies significantly in this group (46.8% with a casual partner and 83.7% with paid partner in 2014). The ability to meet male partners over the Internet adds an extra challenge to measuring and reaching this population. Current service models could potentially be reviewed in light of the role of Internet dating in moving MSM out of current 'hot-spots' and these factors will need to be taken into account when considering scale-up of these programs.

10 **MSW remain a challenging group to reach.** MSW can face stigmatization and discrimination both for having sex with men, and for having commercial sex[65]. MSW are at a high risk of contracting HIV for biological, behavioral and structural

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64 Mikik et al, 2014b.

65 Baral et al. 2015.Male sex workers: practices, contexts, and vulnerabilities for HIV acquisition and transmission. Lancet 2015; 385: 260–73.

reasons—yet in many settings around the world, this group has not received adequate attention[66]. In the case of FYR Macedonia's MSW population, this group should be a central focus of the HIV response. As mentioned above, programs for sex workers may need to consider innovative ways to better map and scale up programs targeted at the MSW group. Further research specifically amongst this group would be beneficial and ongoing work to change the structural determinants of discrimination and stigma needs to be a core focus.

11 **Additional domestic resources will be needed to sustain the HIV response after the withdrawal of Global Fund support.** Although funding for HIV in FYR Macedonia has increased since 2008, international donors have financed much of this increase. Preventive programs and programs targeted at key populations are primarily funded by international donors. As such, the withdrawal of international funding without a concurrent increase in domestic funding, will have a significant negative impact on the HIV epidemic in Macedonia. Transitional funding mechanisms need to be explored with the aim of raising domestic funding to at least the level of the current total budget for the HIV response. **International donor funding must be replaced with alternate funding.**

[66] Ibid.

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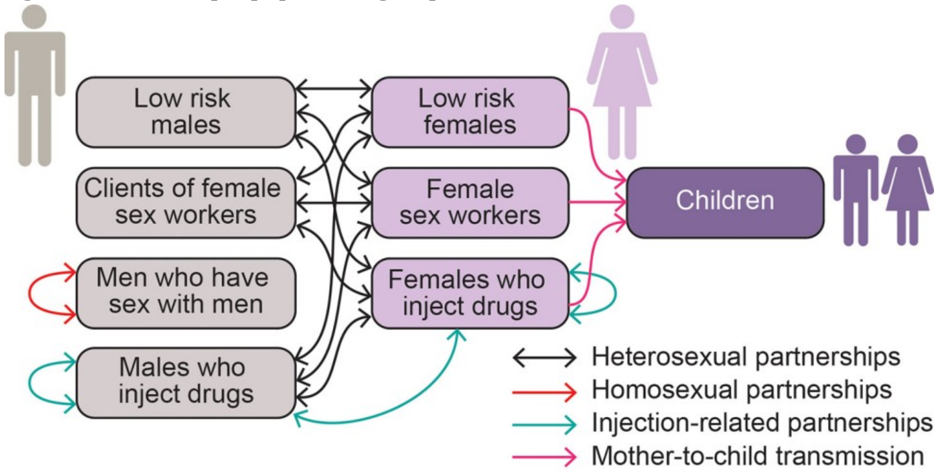
APPENDIXES

APPENDIX A TECHNICAL SUMMARY OF OPTIMA

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

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



Source: Graphic prepared by UNSW study team.

The model uses a linked system of ordinary differential equations to track the movement of PLHIV among HIV health states. The full set of equations is provided in the supplementary material to a summary paper on the Optima model. The overall population is partitioned in two ways: by population group and by HIV health state. Individuals are assigned to a given population group based on their dominant risk.[67] 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

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

transmission probability β varies across CD4 count compartments (indirectly reflecting the high viral load at early and late stages of infection); differs for different modes of transmission (intravenous drug injection with a contaminated needle-syringe, penile-vaginal or penile-anal intercourse, and mother-to-child); and may be reduced by behavioral interventions (for example, condom use), biological interventions (for example, male circumcision), or ART. There is one force-of-infection term for each type of interaction, for example, casual sexual relationships between male sex workers and female sex workers (FSW). The force-of-infection for a given population will be the sum of all interaction types.[68] 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.[69] 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.[70]

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[68] 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.

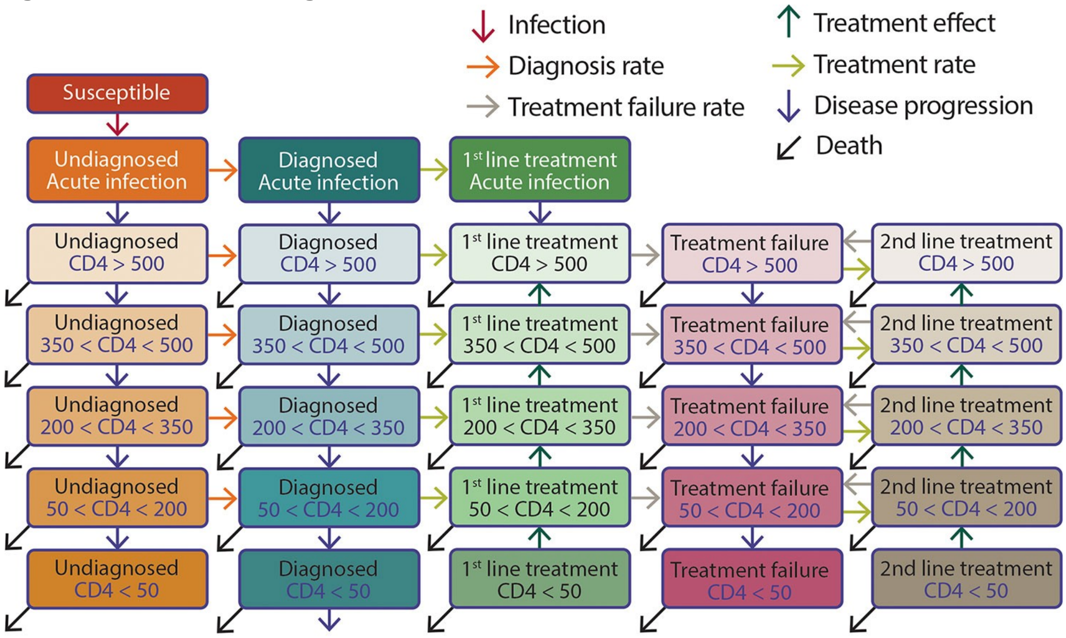
[69] First, individuals may die, either because of an average background death rate for that population (which is greater for older populations or for people who inject drugs) or because of HIV/AIDS (which depends on CD4 count). Second, in the absence of treatment, individuals progress from higher to 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.

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

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

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

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



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

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

Table A.1 Input parameters of the model

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

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

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

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

HIV Resource Optimization and Program Coverage Targets

A novel component of Optima is its ability to calculate allocations of resources that optimally address one or more HIV-related objectives (for example, impact-level targets in a country's HIV national strategic plan). Because this model also calculates the coverage levels required to achieve these targets, Optima can be used to inform HIV strategic planning and the determination of program coverage levels. The key assumptions of resource optimization are the relationships among (1) the cost of HIV programs for specific target populations, (2) the resulting coverage levels of targeted populations with these HIV programs, and (3) how these coverage levels of HIV programs for targeted populations influence behavioral and clinical outcomes. Such relationships are required to understand how incremental changes in spending (marginal costs) affect HIV epidemics.[71] 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

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

responses.[72] To perform the optimization, Optima uses a global parameter search algorithm called Bayesian adaptive locally linear stochastic descent (BALLSD). BALLSD is similar to simulated annealing in that it makes stochastic downhill steps in parameter space from an initial starting point. However, unlike simulated annealing, BALLSD chooses future step sizes and directions based on the outcome of previous steps. For certain classes of optimization problems, the team has shown that BALLSD can determine optimized solutions with fewer function evaluations than traditional optimization methods, including gradient descent and simulated annealing.

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

Uncertainty Analyses

Optima uses a Markov chain Monte Carlo (MCMC) algorithm for performing automatic calibration and for computing uncertainties in the model fit to epidemiological data. With this algorithm, the model is run many times (typically, 1,000–10,000) to generate a range of epidemic projections. Their differences represent uncertainty in the expected epidemiological trajectories. The most important assumptions in the optimization analysis are associated with the cost-coverage and coverage-outcome curves. To incorporate uncertainty in these curves, users define upper and lower limits for both coverage and behavior for no spending and for very high spending.[73]

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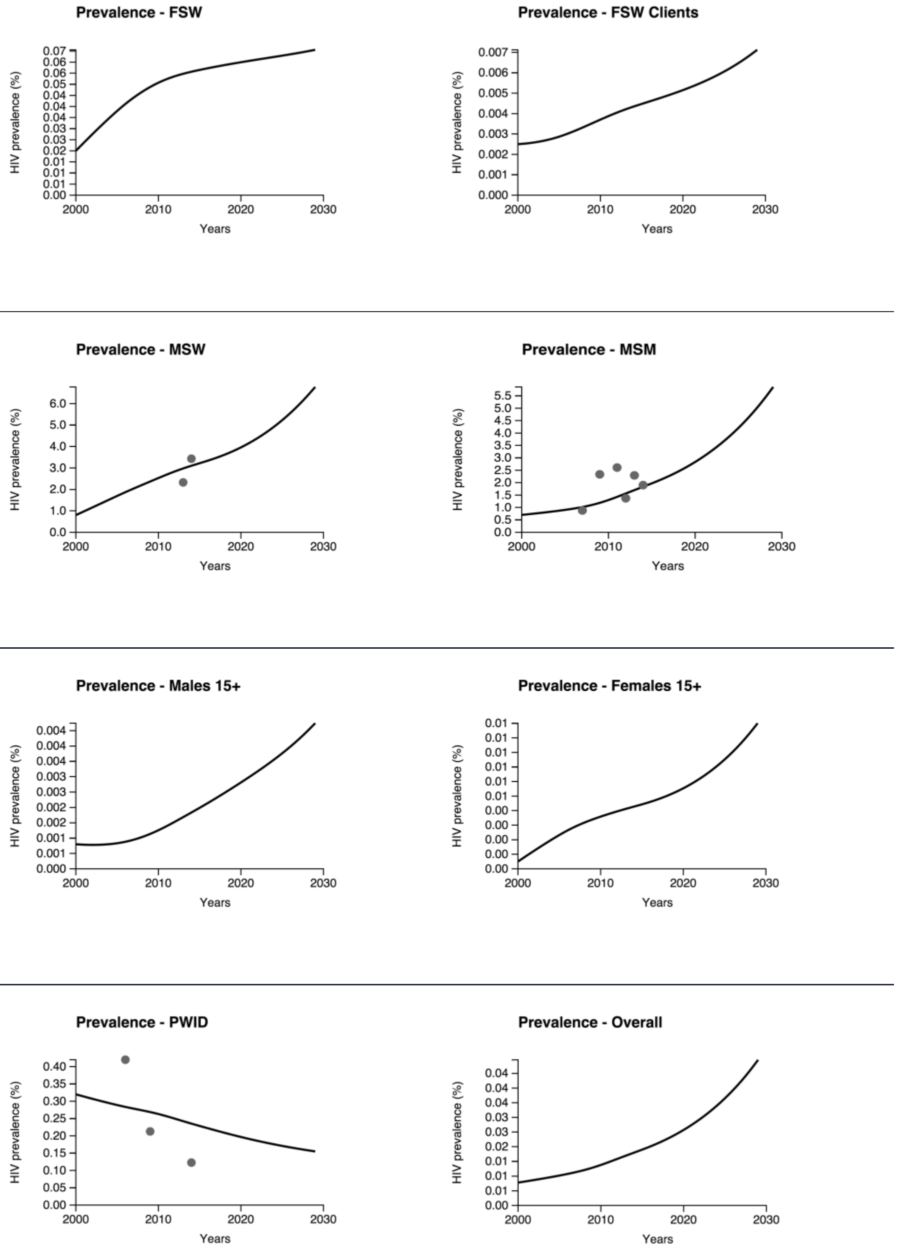
72 Program coverage for zero spending, or behavioral outcomes for zero coverage of formal programs, is inferred using data from early on in the epidemic or just before significant investment in HIV programs. Practically, the team also discussed the zero and high spending cases with local experts, who 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).

73 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 FIGURES

Figure B.1 Calibration of the overall HIV prevalence and the HIV prevalence among key populations[74]



In the calibration process, model parameters were varied in order to obtain the most accurate fit from the available IBBS data for the MSM, MSW, FSW and PWID populations. Data for the clients and general populations were very limited and therefore assumptions were made based on number of diagnosed HIV cases. Furthermore, data from registered new cases was also used to predict the trends in the epidemic. There was a large spread in the historic data, especially in the MSM HIV prevalence data. In deriving an estimate for the MSM curve, the lower-bound estimates were used and curves for the MSW and PWID populations go through averages of the data points (See Figure B2).

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

The combination of relatively late diagnosis, together with low testing rates suggests that there is a higher number of PLHIV than currently diagnosed.

Figure B2 Model calibration to overall incidence of HIV

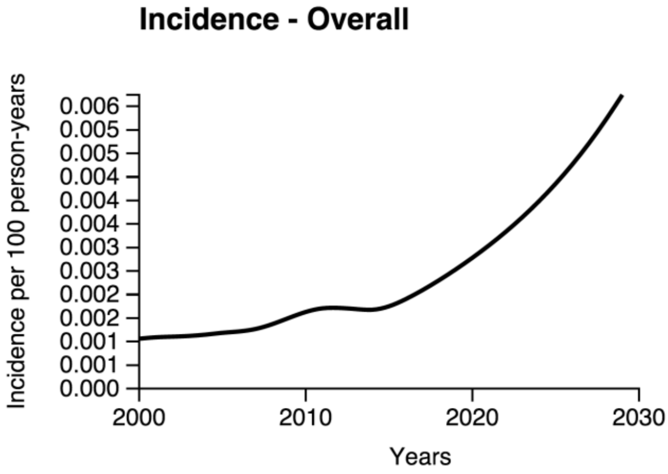


Figure B3 Model calibration to overall new HIV infections

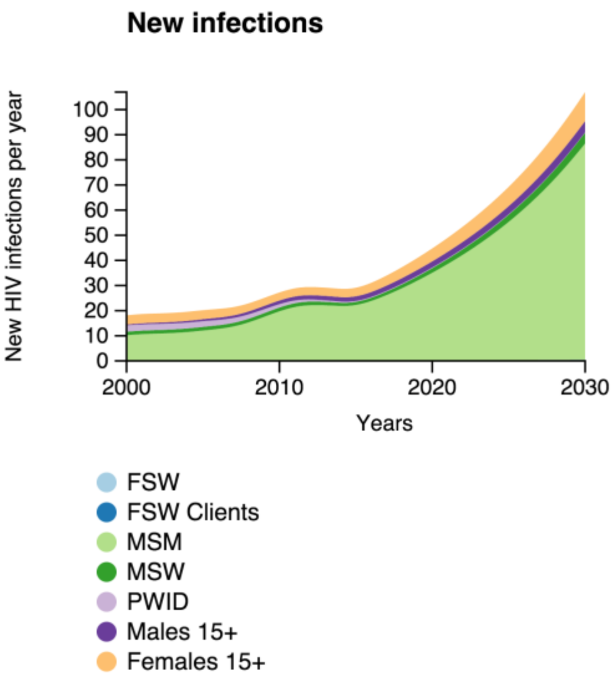
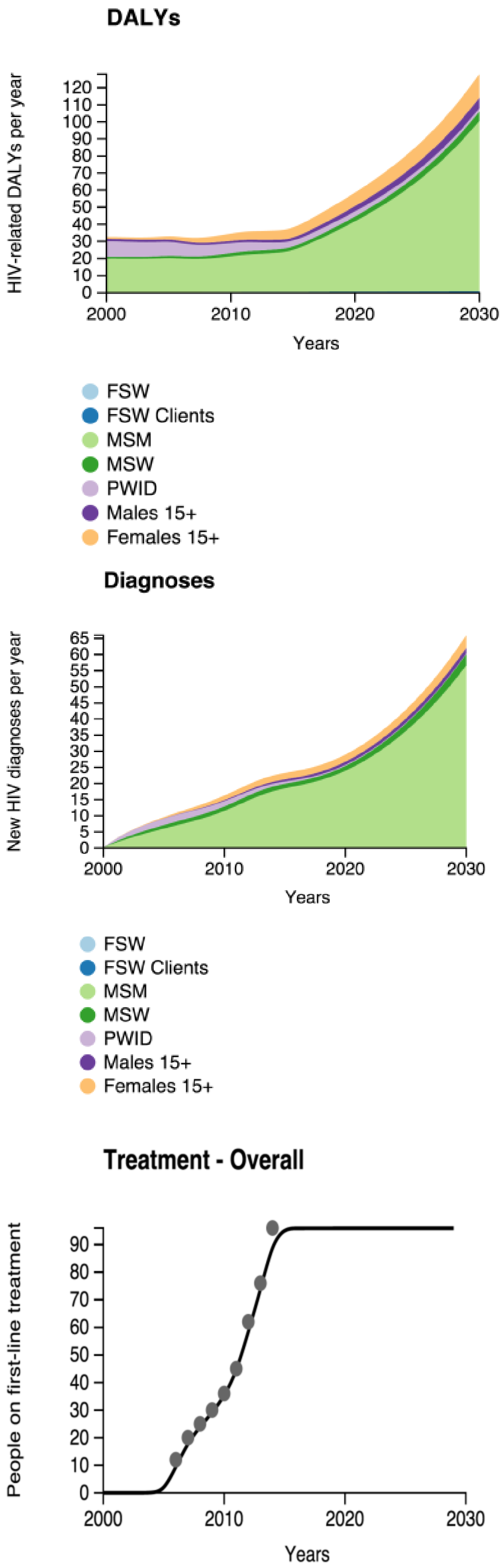


Figure B5 Model calibration of number of DALYs, HIV diagnoses, and overall treatment



APPENDIX C COST COVERAGE OUTCOME CURVES

Table C1 Selected behaviors affected by HIV programs

HIV Program	Targeted Behavior (correlating parameter in model)
Programs for female sex workers and clients (package)	Proportion of sexual acts in which condoms are used with commercial partners (FSW, MSW)
Programs for men who have sex with men (package)	Proportion of sexual acts in which condoms are used with casual partners (MSM)
Opiate substitution therapy	Number of people on OST (PWID)
Needle-syringe program (NSP) and other prevention for PWID (package)	Proportion of injections using receptively shared needle-syringes (PWID) Proportion of sexual acts in which condoms are used with commercial partners (PWID)
HIV testing and counseling	Proportion of people who are tested for HIV each year (FSW, MSW, MSM, PWID)
Antiretroviral therapy	Number of people on ART (all population groups)

Cost-coverage outcome curves for FSW and MSW programs

Figure C1 FSW and MSW—proportion of people who are covered by sex worker programs each year

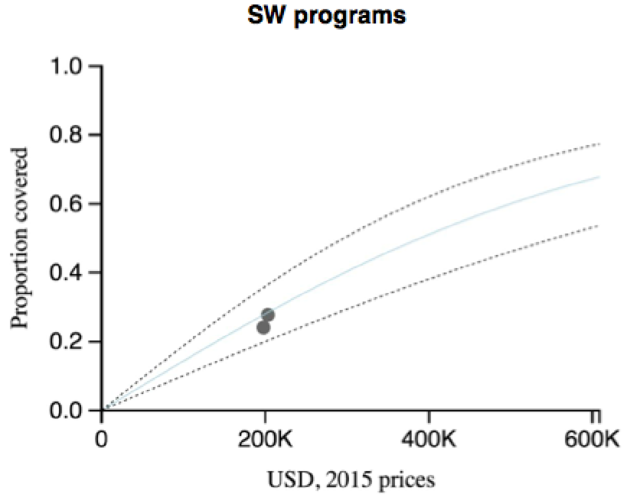


Figure C2 FSW—proportion of people who are tested for HIV each year

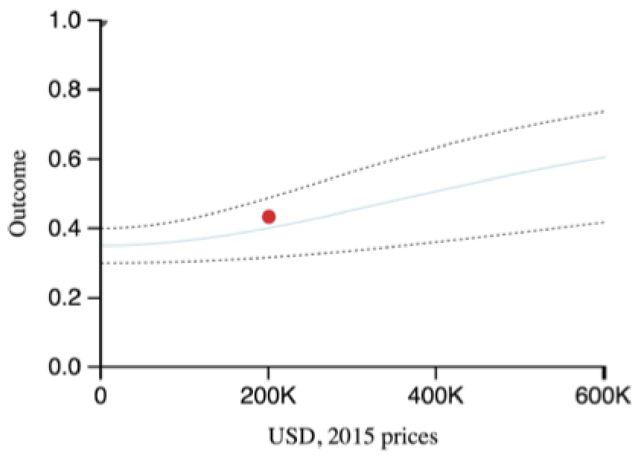


Figure C3 MSW—proportion of people who are tested for HIV each year

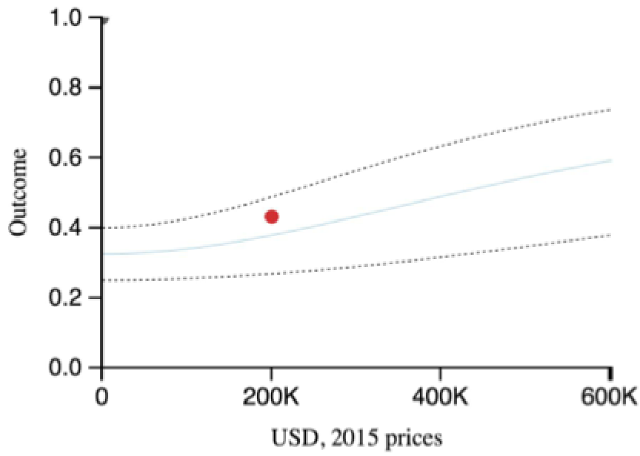


Figure C4 FSW—Proportion of sexual acts in which condoms are used with commercial partners

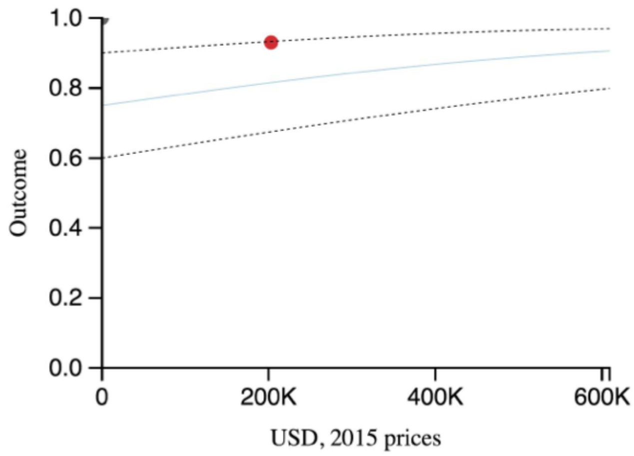
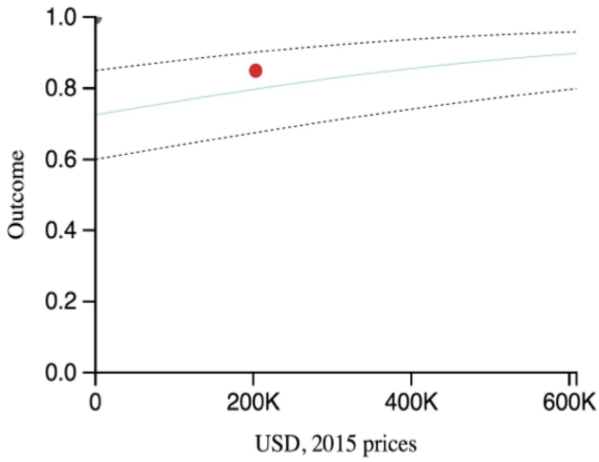


Figure C5 MSW—proportion of sexual acts in which condoms are used with commercial partners



Cost-coverage outcome curves for MSM programs

Figure C6 MSM—proportion of people covered by MSM programs

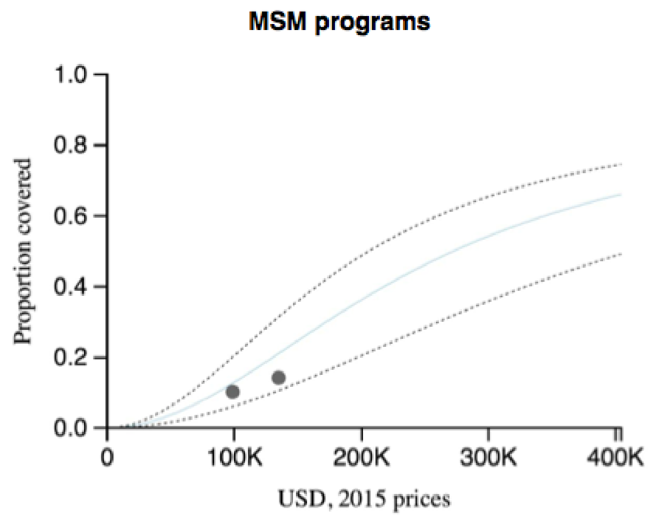


Figure C7 MSM—proportion of sexual acts in which condoms are used with casual partners

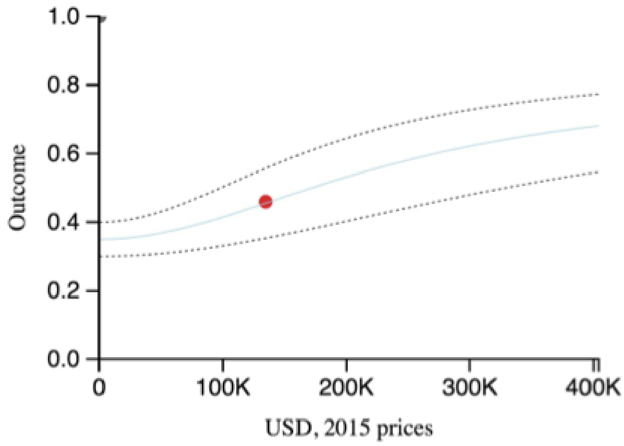
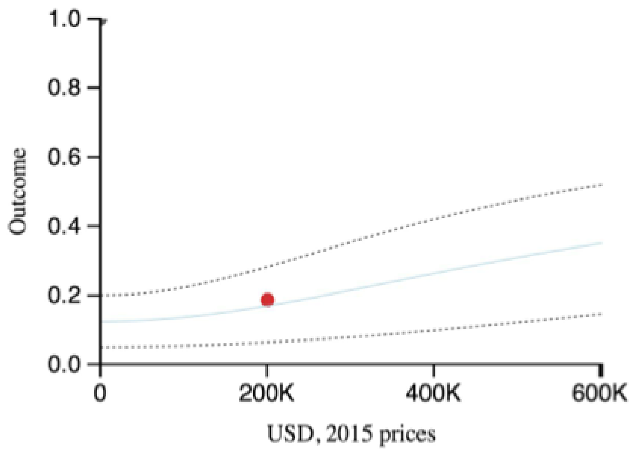
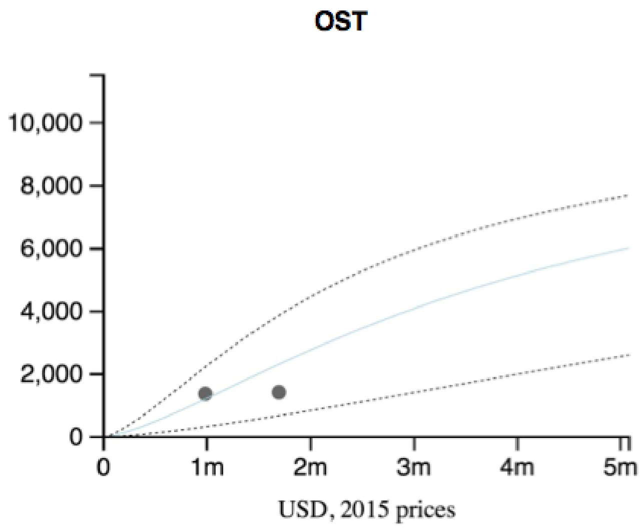


Figure C8 MSM—proportion of people tested for HIV each year



Cost-coverage outcome curve for OST programs

Figure C9 Opiate substitution therapy—number of people covered



Cost-coverage outcome curve for needle-syringe program and other prevention for PWID

Figure C10 PWID—proportion of people covered by PWID programs

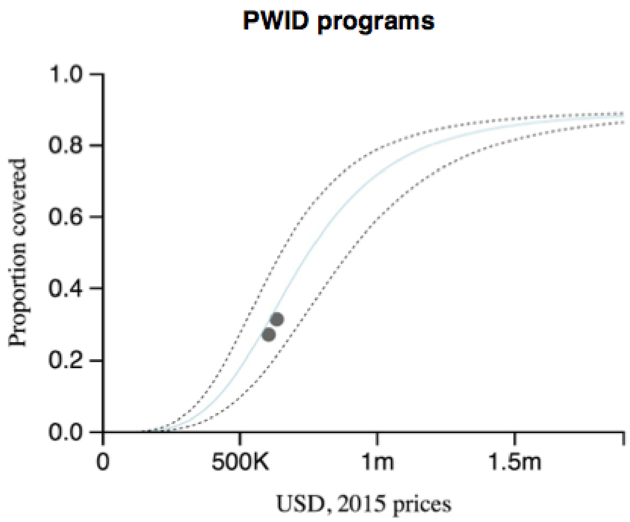


Figure C11 PWID—proportion of injections using receptively shared needle-syringes

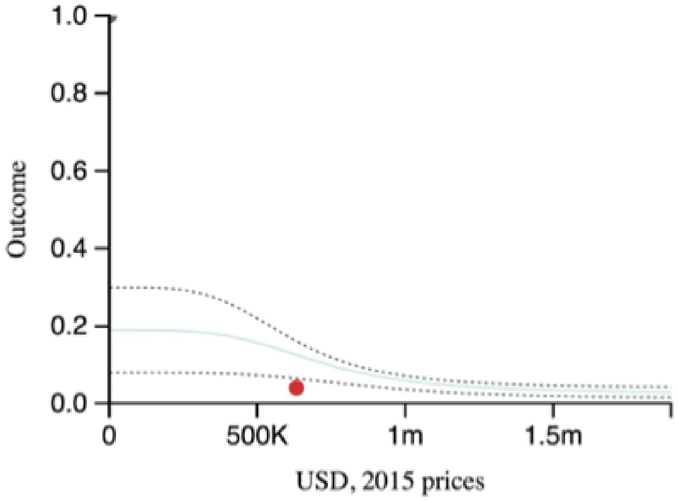


Figure C12 PWID—proportion of people who are tested for HIV each year

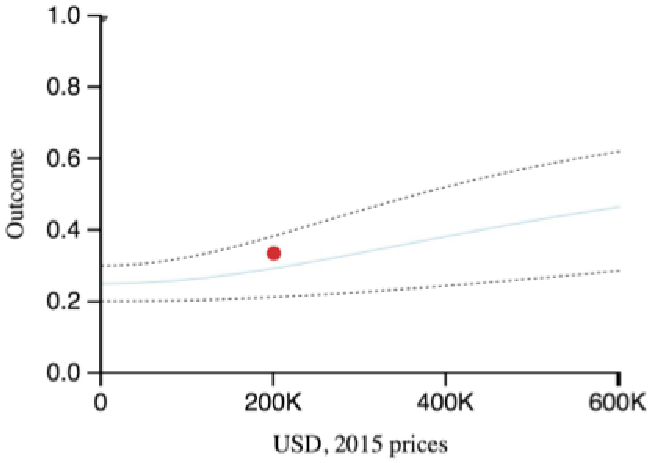
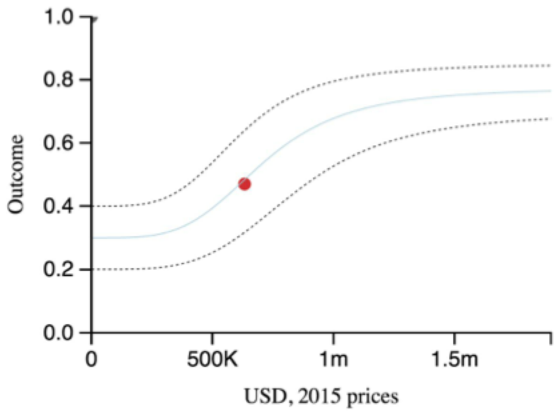


Figure C14 PWID—proportion of sexual acts in which condoms are used with casual partners



Cost-coverage outcome curves for general population male and female 15+ population groups

Figure C13 Males 15+ population – proportion of sexual acts in which condoms have been used with casual partners

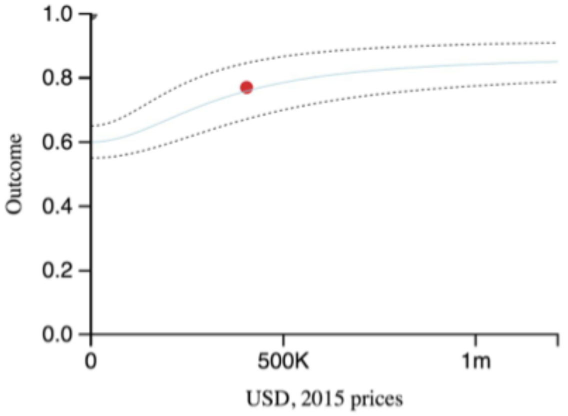
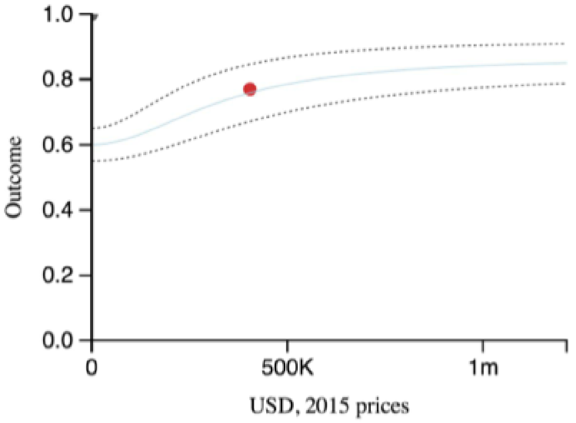
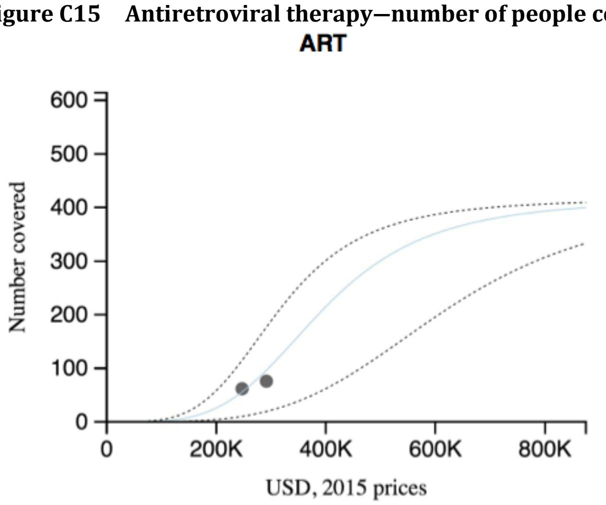


Figure C14 Females 15+ population—proportion of sexual acts in which condoms have been used with casual partners



Cost-coverage outcome curve for ART

Figure C15 Antiretroviral therapy—number of people covered (all population groups)



APPENDIX D DATATABLES

Table D1 Population size (Thousands)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumption
FSW	High	–	–	–	–	–	–	–	–	–	–	6.7	–	–	–	5.6	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	2.6	–	–	–	2.1	OR	–
	Low	–	–	–	–	–	–	–	–	–	–	1.4	–	–	–	1.2	OR	–
FSW Clients	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	52.6
	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
MSM	High	–	–	–	–	–	–	–	–	–	–	36.4	–	–	–	–	OR	–
	Best	11.3	–	–	–	–	15.3	–	–	–	–	19.3	–	–	–	–	OR	–
	Low		–	–	–	–	–	–	–	–	–	11.3	–	–	–	–	OR	–
MSW	High		–	–	–	–	–	–	–	–	–	2.7	–	–	–	3.8	OR	–
	Best	0.6	–	–	–	–	0.8	–	–	–	–	1.0	–	–	–	1.5	OR	–
	Low	–	–	–	–	–	–	–	–	–	–	0.6	–	–	–	0.8	OR	–
PWID	High	–	–	–	–	–	–	–	–	–	–	14.6	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	11.5	–	–	–	–	OR	–
	Low	–	–	–	–	–	–	–	–	–	–	9.8	–	–	–	–	OR	–
Males 15+	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	–	768.7	OR	–
	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
Females 15+	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	–	858.1	OR	–
	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–

65

Table D2 HIV prevalence (Percentage)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumption
	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.05%
FSW	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.0052%
FSW Clients	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.90%	OR	–
	Best	–	–	–	–	–	–	–	0.88%	–	2.33%	0.00%	2.61%	1.37%	2.29%	1.90%	OR	–
MSM	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.50%	OR	–
	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	2.33%	3.43%	OR	–
MSW	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	0.42%	–	–	0.21%	–	–	–	–	0.12%	OR	–
PWID	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.0052%
Males 15+	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	High	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–
	Best	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.0010%
Females 15+	Low	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	–

Table D3 Testing and treatment

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumption
Testing rate per year (%)	FSW	–	–	–	–	–	–	–	–	–	–	33%	–	–	–	44%	OR	–
	FSW Clients	–	–	–	–	–	–	–	–	–	–		–	–	–		OR	0%
	MSM	–	–	–	–	–	–	–	–	–	–	15%	–	–	–	19%	OR	–
	MSW	–	–	–	–	–	–	–	–	–	–	33%	–	–	–	44%	OR	–
	PWID	–	–	–	–	–	–	–	–	–	–	39%	–	–	–	33%	OR	–
	Males 15+	–	–	–	–	–	–	–	–	–	–		–	–	–		OR	2.01%
	Females 15+	–	–	–	–	–	–	–	–	–	–		–	–	–		OR	1.38%
Probability being tested with CD4 <200 per year		30%	–	–	–	40%	–	–	50%	–	–	60%	–	–	–	–	OR	–
No. on first-line treatment		0	0	0	0	0	0	12	20	25	30	36	45	62	76	96	OR	–
No. on subsequent lines treatment		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	1.5
Treatment eligibility criterion		200	200	200	200	200	200	200	200	200	200	350	350	350	350	350	OR	–
Percentage of people covered by pre-exposure prophylaxis	FSW	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	OR	–
	FSW Clients	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	OR	–
	MSM	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	OR	–
	MSW	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	OR	–
	PWID	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	OR	–
	Males 15+	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	OR	–
	Females 15+	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	OR	–

Table D3 Testing and treatment *(continued)*

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumption
No women on PMTCT (Option B/B+)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	OR	–
Birth rate (births per woman per year)	FSW	0.042	0.041	0.04	0.04	0.04	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.035	–	OR	–
	Females 15+	0.033	0.033	0.032	0.032	0.032	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.028	–	OR	–
% HIV-positive women who breastfeed		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0%

Table D4 Optional indicators

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of HIV tests per year	3,434	2,458	2,808	4,322	4,983	7,526	11,172	10,574	10,426	11,842	18,721	17,811	18,105	24,562	27,340
Number of HIV diagnoses per year	6	3	3	1	6	10	17	7	10	8	15	9	24	27	42
Modeled estimate of new HIV infections per year	–	–	–	–	–	–	–	–	–	–	–	–	–	20.00	–
Modeled estimate of HIV prevalence	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	–
Number of HIV-related deaths	3	3	4	2	1	4	5	2	4	1	1	5	0	2	4
Number of people initiating ART each year	–	–	–	–	–	–	–	–	–	–	–	11.00	17.00	15.00	29.00

Table D5 Sexual acts per person per year

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumption
Average no. regular sexual acts	FSW	–	–	–	–	–	–	–	–	–	–	42	–	–	–	36	OR	–
	FSW Clients	–	–	–	–	–	–	–	–	–	–	–	–	–	–		OR	54
	MSM	–	–	–	–	–	–	–	–	–	–	36	–	–	–	43	OR	–
	MSW	–	–	–	–	–	–	–	–	–	–	17	–	–	–	25	OR	–
	PWID	–	–	–	–	–	–	–	–	–	–	90	–	–	–	90	OR	–
	Males 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	54
	Females 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	54
Average no. casual sexual acts	FSW	–	–	–	–	–	–	–	–	–	–	12	–	–	–	9	OR	–
	FSW Clients	–	–	–	–	–	–	–	–	–	–	–	–	–	–		OR	5.5
	MSM	–	–	–	–	–	–	42	46	–	–	47	–	–	–	46	OR	–
	MSW	–	–	–	–	–	–	–	–	–	–	5	–	–	–	6	OR	–
	PWID	–	–	–	–	–	–	–	–	–	–	20	–	–	–	15	OR	–
	Males 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	5.5
	Females 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	5.5
Average no. commercial sexual acts	FSW	–	–	–	–	–	–	–	–	–	–	395	–	–	–	292	OR	–
	FSW Clients	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	12
	MSM	–	–	–	–	–	–	–	–	–	–	9	–	–	–	9	OR	–
	MSW	–	–	–	–	–	–	–	–	–	–	159	–	–	–	201	OR	–
	PWID	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	12
	Males 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0
	Females 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0

Table D6 Condom use, and circumcision probability

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumption
Condom use % for regular acts	FSW	–	–	–	–	–	–	–	61.0%	–	–	31.5%	–	–	–	42.3%	OR	–
	FSW Clients	–	–	–	–	–	–	–		–	–		–	–	–	–	OR	37%
	MSM	–	–	–	–	–	–	–	27.2%	–	–	36.2%	–	–	–	26.6%	OR	–
	MSW	–	–	–	–	–	–	–	61.0%	–	–	31.5%	–	–	–	42.3%	OR	–
	PWID	–	–	–	–	–	41.0%	44.0%	34.0%	–	54.4%	–	–	–	–	46.5%	OR	–
	Males 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	14%
	Females 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	14%
Condom use % for casual acts	FSW	–	–	–	–	–	–	–	–	–	–	64.1%	–	–	–	70.7%	OR	–
	FSW Clients	–	–	–	–	–	–	–	–	–	–		–	–	–	–	OR	67%
	MSM	–	–	–	–	–			69.0%			35.9%	–	–	–	46.8%	OR	–
	MSW	–	–	–	–	–	–	–	–	–	–	64.1%	–	–	–	70.7%	OR	–
	PWID	–	–	–	–	–	–	–	–	–	54%	–	–	–	–	47%	OR	–
	Males 15+	–	–	–	–	–	77%	–	–	–	–	–	–	–	–	–	OR	–
	Females 15+	–	–	–	–	–	77%	–	–	–	–	–	–	–	–	–	OR	–
Condom use % for commercial acts	FSW	–	–	–	–	–	–	–	73.6%	–	–	89.6%	–	–	–	93.3%	OR	–
	FSW Clients	–	–	–	–	–	–	–	–	–	–		–	–	–	–	OR	91%
	MSM	–	–	–	–	–	–	–	–	–	–	48%	–	–	–	84%	OR	–
	MSW	–	–	–	–	–	–	–	–	–	–	80%	–	–	–	85%	OR	–
	PWID	–	–	–	–	–	–	–	–	–	–	100%	–	–	–	60%	OR	–
	Males 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0%
	Females 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0%
Circumcision probability	FSW Clients	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	35%
	MSM	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	35%
	MSW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	35%
	PWID	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	35%
	Males 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	35%

Table D7 Non HIV deaths, STIs and TB prevalence (percentage)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Assumption	
% People die from non-HIV-related causes per year	FSW	0.17%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	–	–	–	–	OR	–
	FSW Clients	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%	0.15%	0.15%	0.15%	0.15%	0.15%	–	–	–	–	OR	–
	MSM	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%	0.15%	0.15%	0.15%	0.15%	0.15%	–	–	–	–	OR	–
	MSW	0.35%	0.35%	0.35%	0.34%	0.34%	0.34%	0.31%	0.31%	0.31%	0.31%	0.31%	–	–	–	–	OR	–
	PWID	1.22%	1.21%	1.21%	1.21%	1.21%	1.20%	1.08%	1.08%	1.08%	1.08%	1.08%	–	–	–	–	OR	–
	Males 15+	1.21%	1.19%	1.18%	1.17%	1.16%	1.15%	1.20%	1.19%	1.18%	1.18%	1.17%	–	–	–	–	OR	–
	Females 15+	0.97%	0.96%	0.95%	0.94%	0.93%	0.92%	1.04%	1.04%	1.03%	1.02%	1.02%					OR	–
Prevalence of ulcerative STIs	FSW	–	–	–	–	–	–	–	–	–	–	0.40%	–	–	–	2.90%	OR	–
	FSW Clients	–	–	–	–	–	–	–	–	–	–		–	–	–	–	OR	2.4%
	MSM	–	–	–	–	–	–	–	–	–	–	0.10%	–	–	–	0.60%	OR	–
	MSW	–	–	–	–	–	–	–	–	–	–		–	–	–	2.90%	OR	–
	PWID	–	–	–	–	–	–	–	–	–	–		–	–	–	0.60%	OR	–
	Males 15+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	OR	–
	Females 15+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	OR	–
Prevalence of discharging STIs	FSW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	17%
	FSW Clients	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	10%
	MSM	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	2%
	MSW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	17%
	PWID	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	5%
	Males 15+	0.000%	0.001%	0.000%	0.000%	0.000%	0.001%	0.002%	0.001%	0.003%	0.002%	0.002%	0.014%	0.012%	0.031%	0.029%	OR	–
	Females 15+	0.000%	0.001%	0.000%	0.000%	0.000%	0.001%	0.002%	0.001%	0.003%	0.002%	0.002%	0.014%	0.012%	0.031%	0.029%	OR	–
Tuberculosis prevalence	FSW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.02%
	FSW Clients	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.02%
	MSM	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.02%
	MSW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.02%
	PWID	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0.02%
	Males 15+	0.06%	0.06%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.04%	0.03%	0.03%	0.03%	0.02%	0.02%	0.02%	OR	–
	Females 15+	0.06%	0.06%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.04%	0.03%	0.03%	0.03%	0.02%	0.02%	0.02%	OR	–

Table D8 Injecting drug use parameters

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014		Assumption
Average no. injections/ person/yr	FSW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0
	FSW Clients	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0
	MSM	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0
	MSW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0
	PWID	–	–	–	–	–	–	–	–	–	–	–	–	–	–	188	OR	–
	Males 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0
	Females 15+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OR	0
Drug use parameters	% shared injections	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.6%	OR	–
	PWID on OST	–	–	–	–	–	–	921	340	610	880	1140	1400	1379	1607	1345	OR	–

Table D9 Transitions

		FSW	FSW Clients	MSM	MSW	PWID	Males 15+	Females 15+
Age-related transitions	FSW	–	–	–	–	–	–	–
	FSW Clients	–	–	–	–	–	–	–
	MSM	–	–	–	–	–	–	–
	MSW	–	–	–	–	–	–	–
	PWID	–	–	–	–	–	–	–
	Males 15+	–	–	–	–	–	–	–
	Females 15+	–	–	–	–	–	–	–
Risk-related transitions	FSW	–	–	–	–	–	–	20
	FSW Clients	–	–	–	–	–	–	–
	MSM	–	–	–	–	–	–	–
	MSW	–	–	–	–	–	20	–
	PWID	–	–	–	–	–	19	–
	Males 15+	–	–	–	–	–	–	–
	Females 15+	–	–	–	–	–	–	–

Table D10 Partnerships

		FSW	FSW Clients	MSM	MSW	PWID	Males 15+	Females 15+
Regular sexual interactions	FSW	–	–	–	–	–	–	–
	FSW Clients	1	–	–	–	–	–	5
	MSM	–	–	4	–	–	–	1
	MSW	–	–	–	–	–	–	1
	PWID	3	–	–	–	–	–	1
	Males 15+	1	–	–	–	–	–	10
	Females 15+	–	–	–	–	–	–	
Casual sexual interactions	FSW	–	–	–	–	–	–	–
	FSW Clients	1	–	–	–	–	–	10
	MSM	–	–	1	–	–	–	–
	MSW	–	–	–	–	–	–	1
	PWID	1	–	–	–	–	–	1
	Males 15+	1	–	–	–	–	–	10
	Females 15+	–	–	–	–	–	–	–
Commercial sexual interactions	FSW	–	–	–	–	–	–	–
	FSW Clients	1	–	–	–	–	–	–
	MSM	–	–	–	1	–	–	–
	MSW	–	–	–	–	–	–	–
	PWID	–	–	–	–	–	–	–
	Males 15+	–	–	–	–	–	–	–
	Females 15+	–	–	–	–	–	–	–
Injecting interactions	FSW	–	–	–	–	–	–	–
	FSW Clients	–	–	–	–	–	–	–
	MSM	–	–	–	–	–	–	–
	MSW	–	–	–	–	–	–	–
	PWID	–	–	–	–	1	–	–
	Males 15+	–	–	–	–	–	–	–
	Females 15+	–	–	–	–	–	–	–

APPENDIX E GLOSSARY

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

Opportunistic 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.

APPENDIX F REFERENCES

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