CAPTURE

Data entry tool for estimating marginal costs of new/integrated HIV and TB services

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Glossary

Part A: Key terms

Capacity: the maximum potential output of a unit of production, given available resources

Economies of scale: situation in which production cost per unit of output decreases as the scale of production and, consequently, the volume of output increases

Economies of scope: decrease in the total cost of production when a range of services are produced together rather than separately

Efficiency: general term describing the relationship between inputs and outputs to a production process. In health economics, efficiency refers to either obtaining the greatest health benefit from interventions using the available resources, or achieving a given health benefit in a way that minimises costs/resource use

Fixed cost: A cost/input of production that does not vary with the level of output. In the long run, all costs/inputs are assumed to be variable rather than fixed

Platform: grouping of logistically related delivery channels, capable of implementing packages of interventions that might address heterogeneous sets of health problems[1]

Variable costs: A cost/input of production that varies directly with the level of output

Part B: Model parameters

Cell numbers refer to 'Use Case 1 – Scale up' tab in the Excel based tool

% FTE allocated to service: Percentage of full time equivalent (FTE) dedicated to target service (*H32*)

Average minutes per service visit: Minutes per staff to deliver one visit (*F32*)

Cost per staff: Salary costs at facility level for one staff delivering the target service (*J6*)

Facility Fixed Costs: Costs that are fixed at the facility level but variable at program level. They can include above-service level programmatic costs that are fixed by facility, such as supervision and training (*I6*)

Fixed Program Costs: Above-service level costs, fixed at program level (*H6*)

Max visits fac./year: Annual maximum number of target service visits per facility (*E6*)

Max visits per staff: Annual maximum number of visits per clinical staff per facility (*F6*)

Maximum clinical staff: Maximum number of clinical staff per facility (*C47*)

Total Visits Per Year: Current visits per year for the service at facility level (*E32*)

Variable cost per visit: Drug and supplies costs per visit at facility level (*L6*)

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[1] From: Watkins, D.A., et al., *Universal Health Coverage and Essential Packages of Care*, in *Disease Control Priorities: Improving Health and Reducing Poverty*, D.T. Jamison, et al., Editors. 2017, The International Bank for Reconstruction and Development / The World Bank: Washington (DC).

Introduction

CAPTURE aims to guide analysts conducting incremental analyses of new HIV and TB interventions that are added to an existing primary health care services platform. This data entry and calculation tool is an addendum to any 'off-the-shelf' and custom designed MS Excel-based costing tools[2]. It provides an analytical tool and framework to explore how economies of scale and scope may affect unit and total costs of HIV and TB services at different levels of service coverage.

The tool is based on a mechanistic cost function approach that accounts for variations in unit costs with different levels of scale, scope and integration with other services. It is designed to collate data on the costs of selected primary care services and on the capacity of the primary care delivery platform, and estimate the relationship between costs and scale of operation within existing capacity constraints. The tool uses a mechanistic framework (rather than statistical) to estimate the cost function, accounting for scale and scope effects based on the production function for different services or activities (e.g. diagnosis, treatment, etc) and capacity constraints around different resource types (staff, equipment, drugs and supplies).

The tool is designed to support priority setting and resource allocation decisions in settings where time and data are limited. It can be used for national-level costing analyses, economic evaluations, and as an input to planning and modelling exercises.

It can inform questions about:

1. **Scaling existing or new interventions** within the existing primary care platform
2. **Integrating existing primary care services**
3. **Introducing new delivery channels**.

The tool is designed around these use cases, and the present guidance document describes data needs and model assumptions for each use case in detail below. However, the tool is not intended to replace a full, detailed costing study and its output should not be interpreted as a precise projection of actual costs. Instead, it supports the extrapolation of secondary cost data to local contexts by incorporating country-specific capacity constraints. It provides broad estimates of program costs at different levels of scale, offering a more realistic alternative to approaches that assume constant average costs across the production process.

Rationale and tool design

Depending on the time and place of collection, cost data can vary in terms of platform capacity and of the scale, scope and implementation efficiency of the interventions being assessed. This is true both across and within jurisdictions: as intervention, service or output levels change, unit costs will also change, and thus existing estimates might not be representative of a given context.

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[2] Examples of 'off-the-shelf' tools to generate unit costs that can be used in conjunction with the CAPTURE tool include HERO's HIV Counselling and Testing costing tool, PrEPWatch's PrEP-it, WHO's OneHealth tool and the Global Health Costing Consortium's Value TB suite of tools.

Accounting for local capacity has been identified as an important factor, among others, when adjusting costs to account for scale [1], [2]. However, costing analyses alongside infectious disease modelling usually assume constant marginal costs when modelling services scale up [3], despite evidence against it [4], [5]. This linear approach runs opposite to economic theory that describes how costs should behave along the production process, often ignoring the resulting economies of scale and scope [2].

CAPTURE has developed principles and methods for country-level economic analyses, for estimating the incremental costs of adding and/or integrating HIV interventions to the existing system infrastructure that takes capacity constraints into account. The work drew on the experience of past costing and modelling studies, conducting secondary analyses of data generated by the Integra Initiative [6], and by modellers and economists that informed South Africa's National TB Think Tank [7].

Summary of CAPTURE principles and guidance for country-level economic analyses

Principle

Costing analyses for HIV/TB interventions and services should account for health system capacity constraints when estimating resource needs at scale, to ensure that economies of scale and scope are appropriately captured and align with economic theory.

Methods

Facility level costs should, to the extent possible, be disaggregated into their fixed and variable components.

Where data are available, fixed costs should be further disaggregated by resource type into fixed and semi-fixed, to reflect inputs that exhibit invariant and increasing returns to scale, respectively.

All resource types corresponding to semi-fixed costs involved in the delivery of the services should be costed separately, and cost estimates should be adjusted for the respective capacity constraints.

To parametrize capacity constraints in the cost model, data can be obtained from national level sources including health system human resource norms and standards, health sector strategic plans, or performance reviews, and can be further refined using expert opinion from local stakeholders.

The tool uses a mechanistic cost function, which was developed drawing from published empirical work disaggregating site- and above-site level costs to account for scope and scale effects in the calculation of total incremental intervention costs [2], [3]. Accordingly, the framework outlines the classification of fixed and variable costs into (i) service- vs above-service level, and (ii) service-specific vs. shared.

The basic cost function is defined as follows for total costs C across i facilities and j interventions:

$$C = FP_j + \sum_{i,j}\left(\frac{n}{n\_max}\right)FF_{i,j} + \sum_{i,j}\left(\frac{n}{n\_\max\ \_s}\right)ST_{i,j}x\ staff_{i,j} + \sum_{i,j}\left(\frac{n}{n\_\max\ \_e}\right)E_{i,j}\ x\ equip_{i,j} + \sum_{i,j}(VF\ x\ n)_{i,j}$$

FP are fixed program costs

FF are facility level fixed costs
ST are facility level staff fixed costs
E are equipment costs
VF are facility level variable costs
n is the level of output
n_max is the maximum level of output by type of input.

The cost function consists of several cost terms differentiated by input type, based on their behaviour at scale. The first term (FP) represents fixed programmatic costs, corresponding to inputs that are assumed to present no variation to scale. This is followed by three semi-fixed cost terms (FF, ST, E), which capture inputs expected to exhibit increasing returns to scale. Finally, the variable cost term (VF) represents inputs with constant returns to scale. It is acknowledged that the current specification does not incorporate inputs characterized by decreasing returns to scale[3].

The cost function disaggregates costs traditionally classified as fixed into a set of fixed and semi-fixed costs. Fixed program costs (FP) only encompass above-service level costs that are fixed at the program level. Facility-level costs are further disaggregated: those that are fixed at the facility level but vary at the program level as a function of the number of facilities (given the scale), and those that remain fixed within certain ranges of scale but increase once the maximum capacity of a specific input is reached. The former, facility-level fixed costs (FF) include building, utilities or management costs; they can also include program costs that are incurred above the site level, but are fixed by facility, such as supervision and training. The other terms are input-specific (ST and E), and include staff costs and equipment costs. They will remain fixed until the output *n* reaches their maximum capacity *n_max,* at which point an additional unit of input will be required.

The inclusion of capacity variables and the specification of a functional form support our objective of capturing economies of scale and scope. These refer to the conditions under which long-run average costs decline as the volume of output increases, or as the mix of services expands. These efficiencies emerge when fixed (or semi-fixed) costs—for example, those associated with physical infrastructure and utilities—are spread across larger patient volumes or across a broader array of services. By disaggregating fixed costs into different types of inputs, the model captures multiple sources of economies of scale and scope at different levels of output and scale-up approaches—effects that cannot be adequately captured using a constant average cost approach.

General Instructions

The MS Excel-based data entry and cost estimation tool can be found here: https://capture-tb-hiv.github.io/assets/CAPTURE_mechanistic_cost_function.xlsx

Overview of the Tool

The tool is designed to support the estimation of marginal costs for different health service delivery programs. It can be used by government, international organization and academic staff working in HIV/TB programs, technical assistance and allocative efficiency of HIV and TB, and has

[3] A separate work stream of the CAPTURE project is considering ways of addressing this limitation

been developed as an aid to thought rather than a projection of actual costs. The tool is structured around individual 'Use Case' sheets (green tabs – see figure 1 below), where the tool estimates the program capacity and the marginal costs based on user inputted cost and operational data for the target interventions and service platforms.

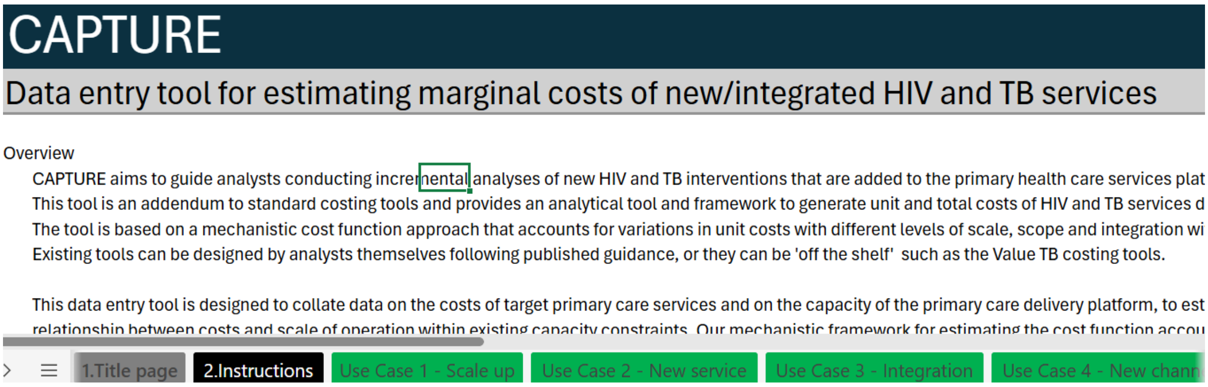

Figure 1. Costing tool layout

Each Use Case sheet includes a section for entering:

- Data on programmatic (above-service) and service-level costs for the target service(s) and service level characteristics
- Data on platform- and system-level characteristics.

Each Use Case has an associated Output sheet, which automatically generates graphs summarizing the results for that specific use case. The graphs will plot total program costs and average costs using the mechanistic cost function and using linear unit costs, to allow comparison of results from the different approaches.

A separate 'Parameter Assumption' sheet contains general inputs and capacity assumptions that apply across all Use Cases, such as the number of working hours in a day, the number of working days per year, or exchange rates.

Each Use Case is parametrised and run independently, making it easy to explore multiple service delivery scenarios, target services or programmatic objectives.

Data Entry Guidelines

Light blue cells are input cells. You should only enter or modify data in these cells. Do not enter data in any other cells, as they contain protected formulas or automated calculations. Green cells are filled automatically with user specified data from the service costs and characteristics sections of the Use Cases. The sheets will estimate and update the grey cells automatically to provide results.

Blue text throughout the sheets provides additional guidance and context for data entry.

In the tool, light blue input cells are pre-filled with sample data from the Integra dataset and other sources. These values are illustrative only and can be fully overwritten with your own data.

Customization and Flexibility

The tool is fully customizable and can be adapted to analyse a range of interventions and services, including scenarios involving service integration. There is no fixed limit to the number of services that can be analysed:

- You can add rows within the Use Case sheets to consider multiple services on the same platform simultaneously
- You may duplicate Use Case sheets to run multiple costing exercises in parallel.

Use cases

Each of the four use cases describes a distinct health service delivery program and objective:

Use Case 1: Scaling up existing PHC services – the function is exemplified by scaling up family planning services.
Use Case 2: Scaling up new services - exemplified by newly introducing Xpert MTB/RIF as a first diagnostic test in PHC services following WHO symptoms screening
Use Case 3: Integrating services within the PHC platform – integrating cervical cancer screening using visual inspection with acetic acid (VIA) into family planning visits.
Use Case 4: New delivery channels – assesses family planning service capacity before and after setting up a new channel for continuation of PreP at private pharmacies rather than at government clinics.

In each case the sheets use the mechanistic cost function and compare the results with a constant average unit cost approach. These instructions will focus on **Use Case 1** (sheet 'Use Case 1 - Scale up'), though they apply uniformly to all Use Cases. When approaches differ, clarifications will be provided for the specific Use Case.

All the data used for the Use Cases is inputted in the blue cells, and includes the 1) desired level of scale for the program (cells *C6 to C25*); 2) programmatic (above-service) and service-level costs for the target service(s) (row *32*); and 3) program characteristics (row *35*).

Level of scale - The scale is specified by the baseline and target number of visits of the target service(s) (*C6* and *C25*). The baseline number of visits is determined by multiplying the initial number of facilities participating in the program (*C41* - set by the user) by the current average utilization per facility (*C46*) sourced from [8]. The target number of visits at scale (*C25*) was estimated as:

$$V_{scale} = pop\ x\ util\ x\ cov\ x\ fte_{fp}$$

Where,

pop: country population (*C38*)
util: target annual utilization per capita per health facility (*C43*) from [9]
Cov: target coverage (*C44*), and
Fte: % FTE allocated to the target service (*H32*)

For Use Case 1, the function is exemplified by scaling up family planning to 90% coverage (cell *C44*). The coverage level is user-specified. The model assumes that scale-up follows existing utilization patterns—specifically, the FTE allocation to family planning remains constant as coverage expands. Consequently, facility-level costs and capacity parameters based on the FTE allocation are held constant throughout the scale-up. The FTE allocation to family planning (currently 12.7%) is sourced from the Integra data as the average across health dispensaries and health centres in the study sample. The number of visits is set to automatically increase exponentially after the baseline and target number of visits are specified in column C.

The target number of visits at scale is estimated separately for each Use Case. For example, for Use Case 2, we assumed that 90% of current PHC visits would receive the WHO screening tool. This estimate was calculated as the number of Ministry of Health-owned health facilities (dispensaries and health centres) multiplied by the average outpatient utilization per facility.

Programmatic (above-service) and service-level costs – The costs and characteristics of the target service(s) are specified in row 32 (see Figure 2 below) at the facility level. The tool requires the **facility-level** fixed costs (above service level), semi-fixed costs (fixed facility, staff, training, equipment) and the variable costs (drugs, supplies, transportation) of the service, which are then used for estimating costs at scale (rows *6* to *25*). The cost data currently presented in the tool are representative values for service specific data at the facility level and are drawn entirely from the Integra dataset. The service-level data used for family planning in Use Case 1 includes:

- Average total visits per year (*E32*)
- Average minutes per target service visit (*F32*)
- % FTE allocated to service (*H32*)
- Number of clinical staff (*I32*)
- Costs (*K32-V32*)

Service	iptic r	Total Visits Per Year	Average minutes per service visit	Average minutes per test - Laboratory staff	% FTE allocated to service	Number of Clinical Staff	Number of Technical staff	Fixed program costs (above-servi ce)	Building Costs	Training costs	Equipment Costs	Admin and Support Costs	Maintenance and Utilities
Family Planning	Th	2649	15		12.70%	3		$28,080.00	$ 217.18		$ 247.67		$ 72.70

Figure 2. Costs and characteristics of the target service(s)

Capacity – The scale variables, max_i and max_s, were estimated using a normative approach that combined national health staffing standards [10] with assumptions on available staff and service delivery times from Integra. The maximum annual visits per nurse (max_s) were calculated as the product of visits per hour (60/*F32*), working hours per day, working days per year and the full-time equivalent (FTE) dedicated to the service (*H32*). The maximum annual visits per facility (max_i) were then obtained by multiplying max_s by the maximum number of staff from the relevant cadre permitted to work in a health centre, as specified in the staffing guidelines.

This approach was adapted as appropriate for each use case. For Use Case 2, three distinct variables were specified for max_k, corresponding to the different input types required to deliver the service—namely, staff (clinical and laboratory) and equipment (the GeneXpert system). The annual maximum visits per staff were estimated as for Use Case 1, using client contact time estimates for the WHO screening tool and sputum collection (for nurses) and Xpert testing (for laboratory technicians), from the South Africa TB Think Tank project [11]. Maximum tests per equipment calculations assumed that each facility is equipped with at least one four-module GeneXpert system capable of performing 20 tests per working day [12]. Finally, maximum annual visits per facility (max_i) were defined as the average visits per facility if the national target utilization rate of three PHC visits per person was achieved [9].

For Use Case 4, it is assumed that the nurse time freed up by shifting some clients to the new delivery channel (private pharmacies) is now available to provide additional units of service on the public primary health care platform.

Data and documentation to derive capacity constraints can be obtained from health system human resource norms and standards reports, health sector strategic plans, or performance reviews, and can be further refined using expert opinion from local stakeholders.

Total program costs – Facility level costs (*K32-V32*) are aggregated into fixed and variable costs (columns *H-L*) to estimate total and average program costs (columns *M-R*).

The aggregated facility-level costs required for the cost function are:

- Fixed program costs (FP – column *H*)
- Fixed facility costs (FF – column *I*)
- Staff costs (ST – column *J*)
- Variable cost per visit (VF – column *L*)

For this Use Case, building (*L32*), equipment (*N32*), maintenance and utility (*P32*) costs were aggregated as fixed facility costs (FF), and salaries (*R32*/*I32*) as staff costs; there were no additional semi-fixed costs (any equipment costs were aggregated with FF as there was no laboratory testing). Variable costs (VF) were derived by dividing drug and supplies cost (*S32-T32*) by the number of visits (*E32*), and fixed program costs (FP) were estimated as a share of total costs across Integra facilities due to data unavailability.

For Use Case 2—scale-up of a new service—the function disaggregated the PHC visit and the Xpert testing into fixed, semi-fixed, and variable cost components. Fixed facility costs combined building, maintenance, and utilities costs. Four distinct semi-fixed costs were specified: staff (clinical and laboratory; columns *M–N*), training (column *L*), and equipment (the GeneXpert system; column *O*). Variable costs are derived in the same way as in Use Case 1; however, there are two separate variable costs: one for the PHC visit and another for the Xpert testing (columns *P–Q*).

For Use Case 3—integration within the PHC platform (cervical cancer screening within family planning)—the function disaggregated family planning costs into fixed and variable costs. Fixed facility (FF) and staff (FK) costs are derived in the same way as in Use Case 1. The function assumes that FF and FK are the same for family planning before and after integration; however, staff capacity is reduced to account for the additional service time required for screening (reflected in the maximum visits per staff and facility).

Then, the tool estimates the total costs at each level of scale:

- 'Total Fixed Program Costs' (column *M*)
- 'Total Facility Fixed Costs' (*N*)
- 'Total Staff Costs' (*O*)
- 'Total Variable Costs' (*P*)

'Total Facility Fixed Costs' are estimated by calculating the number of facilities necessary to deliver the program at the scale level (number of visits, column *C*, divided by the annual maximum number of visits per facility, *E6*) and multiplying by the Facility Fixed Costs (I6).

The same procedure is done for 'Total Staff Costs' with the difference that the number of visits (column *C*) is divided by the maximum number of visits per staff (*F6*) to obtain the number of staff necessary to deliver the program. It is then multiplied by 'Cost per Staff' (*J6*).

The 'Total Variable Costs' are just the 'Variable Cost per Visit' (*L6*) multiplied by the number of visits. Those components are summed to obtain the 'Total Costs' (column *Q*) and then divided by the number of visits to get the ‘Average Cost’ (column *R*) using the mechanistic cost function approach.

Results from the mechanistic cost function are compared with the costs of using a linear costing approach (columns *T-U*): The average linear unit cost ($2.48, column *T*) is calculated by dividing the total service-level costs (*Z32*) by the current visits per year (*E32*). Then, the average cost is multiplied by the number of visits for the target service to obtain the total costs (column U). It is important to note that the costs from the linear approach are derived from the same data used for the mechanistic cost function, not disaggregated into their fixed and variable components.

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