A Deadly Equation: The Global Toll of US TB Funding Cuts

Sandip Mandal, Sreenivas Nair, Suvanand Sahu, Lucica Ditiu, Carel Pretorius

This repository contains codes and data used to simulate and analyse the impact of US TB funding cuts.

1. Impact of funding cuts for representative county 1(low dependency)
2. Impact of funding cuts for representative county 2 (moderate dependency)
3. Impact of funding cuts for representative county 3 (high dependency)

Note: The model code is written in MATLAB and results are saved as MATLAB data files (extension .mat), with plots also being constructed in MATLAB.

**OS System requirements**

The codes developed here are tested on Windows operating system (Windows 10 Home: 64-bit). However as Matlab and Octave are available for most operating systems, codes should run on Mac OSX and Linux as well.

**Installation guide**

MATLAB

Installation instruction for MATLAB can be found at <https://www.mathworks.com/help/install/install-products.html>. Typical install time for MATLAB on a "normal" desktop is around 30-40 minutes. The current codes were developed and tested on MATLAB R2018b.

**Codes & their functionality**

**Setup\_model.m**

This model has 14 state variables which are further stratified into two strains, and diagnosis and treatment compartments are stratified into public and private health care sectors. All the variables and parameter values are assigned in this script.

**make\_model.m**

This is a function which specifies the transmission model in matrix form, capturing the linear and non-linear parts separately.

**goveqs\_basis2.m**

Using the matrix formulation constructed in Make\_model, this computes the time derivatives for each state variable given values for those states.

**get\_address.m**

We make use of Matlab ‘structures’ (the equivalent of ‘lists’ in R) to assist in book-keeping on the indices corresponding to different state variables. This function assists in constructing those indices. For example, the index named i.A.v0.r1.a3 is the index corresponding to the asymptomatic, non-vaccinated, with co-morbidity and among elderly population.

**alloc\_parameters.m**

For a given parameter vector x, this function allocates the corresponding values to each of the parameters being sampled.

**goveqs\_scaleup.m**

This function is used to scaleup/scale-down of the linier matrix constructed in Make\_model.

**get\_objective\_wRNTCP**

This function is used to estimate the likelihood function by solving the equation constructed in goveqs\_basis2.m

**MCMC\_adaptive.m**

Implementation of MCMC adaptive algorithm as described in Haairo et al.

(Reference. Haario H, Saksman E, Tamminen J. An adaptive Metropolis algorithm. *Bernoulli* 2001; **7**: 223–42.)

**Get\_calibrations.m**

This function is used for parameter estimation using MCMC adaptive algorithm.

**linspecer.m**

This function is used to plot multiple lines with distinguishable and well-presenting colors.

**jbfill.m**

This routine will shade the area of a 2-D plot between two user defined vectors.

(Ref. John Bockstege (2021). Shade area between two curves (https://www.mathworks.com/matlabcentral/fileexchange/13188-shade-area-between-two-curves), MATLAB Central File Exchange. Retrieved April 2, 2021.)

**Show\_model\_fits.m**

After model calibration this function shows how the model fits with the input data.

**Simulate\_disruption.m**

This function simulates the model to project the impact of funding disruption in TB incidence and mortality

**Instructions for use**

In the above titled article, there is one figure (Figure 1) in the main text and one figure (Figure S4) in the supplementary document. To generate these figures and output table (Table 1) run the code **Simulate\_disruption.m** for each country folder (i.e country 1 - 3).

**Setup\_model.m**

Model variables and parameter values are assigned in this script. To setup the model for individual country run this code.

**Get\_calibrations.m**

After model setup, run this for model calibration. It may take a few hours to calibrated model and the outputs are saved as *calibres.1.mat*

**Show\_model\_fits.m**

Using the data file (*calibres.1.mat*), generated after calibrating the model run this code to check how the model fits with the input data. (Figure S3, in the appendix)

**Simulate\_disruption.m**

Run this code to see the impact of funding disruption in TB incidence and mortality

**MAT files for each country**

**Country X (here X = 1, 2 and 3)**

CalibresX.mat : Saved calibration outcome

CalibresX\_cal.mat : Saved data to plot calibration figure

CountryX.mat : Saved data to plot disruption on incidence and mortality