Sensitivity Analysis

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1 Overview

We divide our sensitivity analysis into two sections, to analyze the robustness of the deterministic and stochastic models separately. For the deterministic model, we used Latin Hypercube Sampling to test the sensitivity of our model to input parameters from the Hill model and estimates for treatment costs. For the stochastic model, we fixed all input parameters and estimates for treatment costs to default values, and ran the model for 2,000 trials.

2 Deterministic Model

2.1 Latin Hypercube Sampling

Following the example of the Hill model, we generated a Latin Hypercube Sample varying 18 of the input parameters. From these parameters, 16 are identical to the input parameters varied in the sensitivity analysis of the original Hill model, and the remaining two parameters, C_t and C_l, are variables for the average cost of Active and Latent TB treatment in the US. Probability distributions for the original 16 parameters of the Hill model were all set to be Triangular, with mode at the best fit value and end points at the 2.5 and 97.5 percentile values reported in the Hill model. Probability distributions for C_t and C_l were set to be Uniform, with range +/- 10% of the estimated value. All probabilty distributions used to generate the Latin Hypercube are listed in Table 1.

With a random Latin Hypercube Sample of size n=100,000, we computed partial rank correlation coefficients (PRCC) for each of the initial parameters and treatment costs, according to four different outcomes: 1) projected annual incidence in 2100 in the overall population, 2) projected cumulative cost of Latent TB treatments by 2100, 3) projected cumulative cost of Active TB treatments by 2100, 4) projected cumulative total cost of TB treatments by 2100. For outcome 1, PRCC values are shown alongside PRCC values computed in the original Hill model for the same outcome in Table 2, showing the closeness of our findings to the sensitivity results of the original Hill model. PRCC values for the remaining outcomes are reported in Table 3.

Parameter	Distribution
σ_L	Tri(0.015,0.057,0.086)
v_1^L	Tri(0.0009,0.0010,0.0014)
f	Tri(0.157,0.187,0.232)
p	Tri(0.053,0.103,0.137)
ARI_0	Tri(0.00021,0.00030,0.00030)
q	Tri(0.569,0.708,0.825)
g	Tri(0.0008,0.0047,0.0815)
σ_F	Tri(0.419,0.461,0.574)
r_1	Tri(0.759,0.780,0.831)
r_0	Tri(0.623,0.667,0.694)
μ_d	Tri(0.071,0.115,0.231)
x	Tri(0.088,0.111,0.860)
v_0^L	Tri(0.0011,0.0014,0.0015)
ϕ	Tri(0.861,0.897,0.938)
e_0	Tri(0.853,0.965,0.995)
e_1	Tri(0.877,0.985,0.999)
C_t	Uniform(12613,15416)
C_l	Uniform(630,770)

Table 1. Probability distributions for model parameters, where Tri(x,y,z) denotes the Triangular distribution with endpoints (x,z) and mode y.

Parameter	Extended Hill Model	Original Hill model
σ^L	-0.9303	-0.9381
v_1^L	0.7871	0.8309
f	0.7050	0.8072
p	0.8369	0.6100
ARI_0	0.5950	0.4939
q	0.5797	0.4543
g	0.6122	0.4517
σ^F	-0.4911	-0.3772
r_1	0.0028	-0.1109
r_0	0.0018	0.0760
μ_d	0.0923	0.0513
x	0.0999	0.0345
v_0^L	0.0133	0.0266
ϕ	0.0082	0.0177
e_0	0.0178	-0.0072
e_1	0.1154	0.0046
C_t	-0.0023	N/A
C_l	0.0009	N/A

Table 2. PRCC values for projected annual incidence in 2100 in the overall population, alongside corresponding values from the original Hill model.

Parameter	Latent Costs	Active Costs	Total Costs
σ^L	0.9612	-0.9284	0.4169
v_1^L	-0.4190	0.6470	0.3533
f	0.7467	0.5493	0.8083
p	0.3371	0.8810	0.8776
ARI_0	0.3920	0.6728	0.7337
q	0.3837	0.6573	0.7200
g	0.1120	0.5369	0.5182
σ^F	-0.1138	-0.5631	-0.5435
r_1	0.1253	0.0658	0.1401
r_0	0.1325	0.0878	0.1658
μ_d	0.0249	0.0560	0.0613
x	0.0214	0.1282	0.1253
v_0^L	-0.3103	0.0502	-0.1867
ϕ	-0.0023	-0.0102	-0.0107
e_0	0.0081	0.0253	0.0269
e_1	0.0804	0.1653	0.1926
C_t	0.0011	0.7024	0.6385
C_l	0.8515	0.0013	0.7598

Table 3. PRCC values for cumulative US Health Care system costs from Latent TB treatment, Active TB treatment, and Total treatment costs

2.2 Variability due to Uncertainty of Treatment Costs

Next, we performed more extensive multivariate analysis on the economic part of the deterministic model. Keeping all of the input parameters from the Hill model at their default values, we ran the model approximately two million times, varying the cost of treatment for LTBI and Active TB and the treatment rate for incoming LTBI.

2.3 Variability of Intervention Cost for Treating Cases of Incoming LTBI

Similarly, we performed extensive multivariate analysis on the intervention cost for reducing incoming LTBI. With all input parameters from the Hill model at their default values, we ran the model approximately two million times, varying the treatment rate, incidence, and cost to cure for incoming LTBI.

3 Stochastic Model

3.1 Variability due to Probabilistic Nature of Disease Spread

4 Summary