# Modeling Intervention Strategies for United States TB Control

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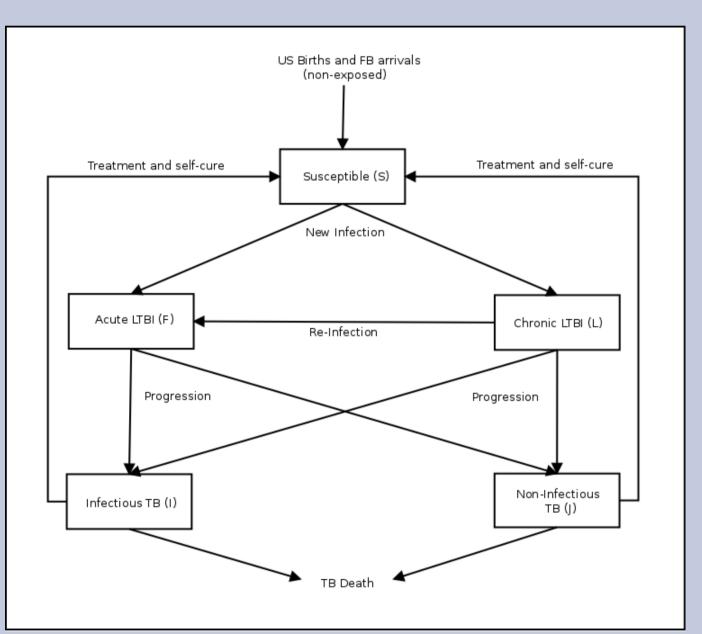




#### Introduction

Epidemiological models offer insight into the structure of disease outbreaks and the merits of various interventions. Compartmental differential equation models are a common model in which populations move between various health states, or compartments, according to predetermined rates. This work is an extension of the Hill Model, a complex compartmental model of tuberculosis (TB) in the United States.

#### The Basic Hill Model



Populations:

- ► US Born (USB)
- ► Foreign Born (FB)
  Individuals also leave the model due to natural death.

Figure: The Hill Model schematic

- ► USB TB incidence rates are declining
- ► FB latent TB infection (LTBI) arrivals remain high
- ► TB elimination in total population not projected by 2100

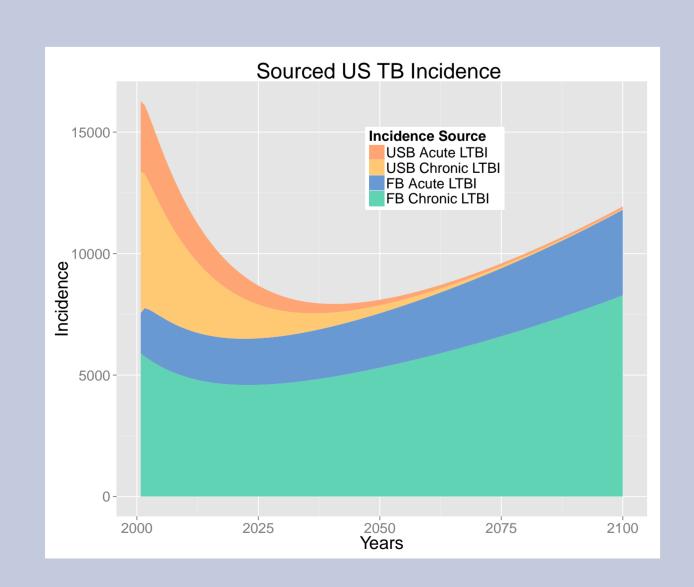
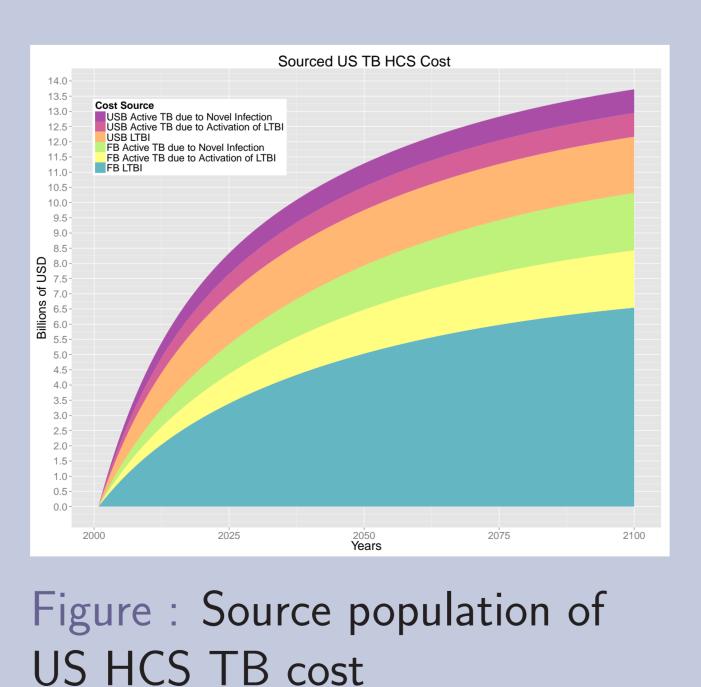


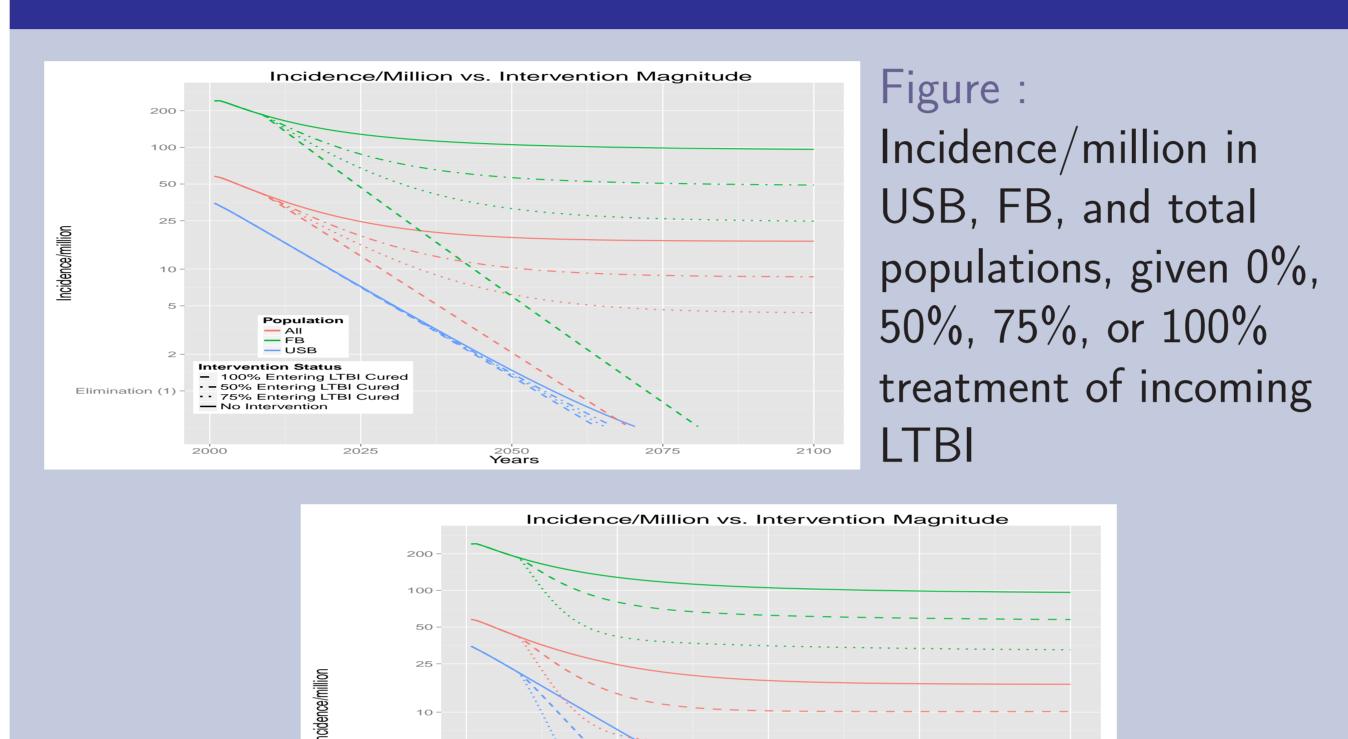
Figure : The source population of US TB incidence



#### Analyzing US TB Reduction Strategies

- Implemented in R, with various numerical DE solvers
- ► Tracks US Health Care System (HCS) cost
- Tracks statistics about various health states

#### Intervention Analysis





Base HCS

Active TB:

\$14,014.90

\$403.45

Costs:

LTBI:

## **Economic Modeling**

- Tracks treatment costs for various disease states
- Estimates implementation cost of intervention

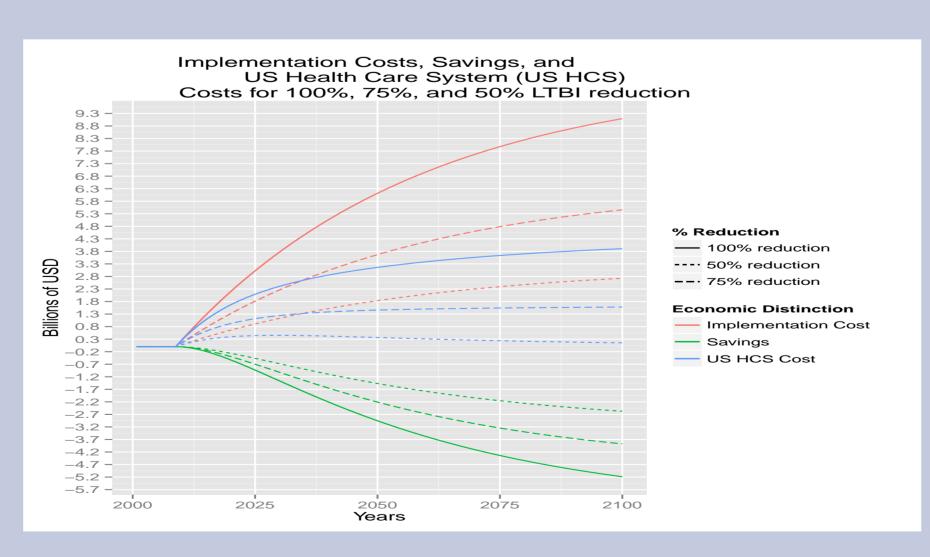


Figure: Cumulative implementation costs, US HCS savings, and net US costs of LTBI arrival cure rates. Cost/case cured was \$600, \$800, and \$1000 for 50%, 75%, and 100% cured

# An Agent-Based Implementation

Agent-based models capture disease dynamics on the individual level and reflect stochasticity and granularity lost in compartmental models. Agent-based counterparts to the Hill model were implemented in Netlogo and C++.

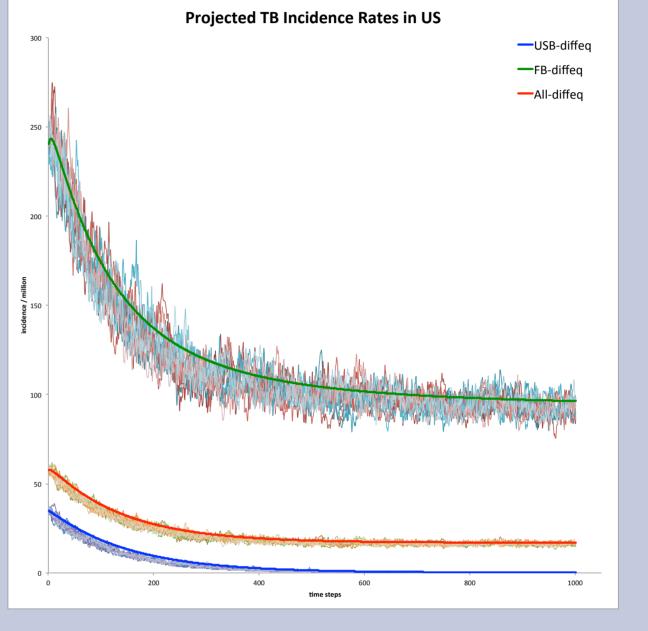


Figure : Incidence/million for R and NetLogo models (12 runs,  $\Delta t = 0.1$ , popConst = 100)

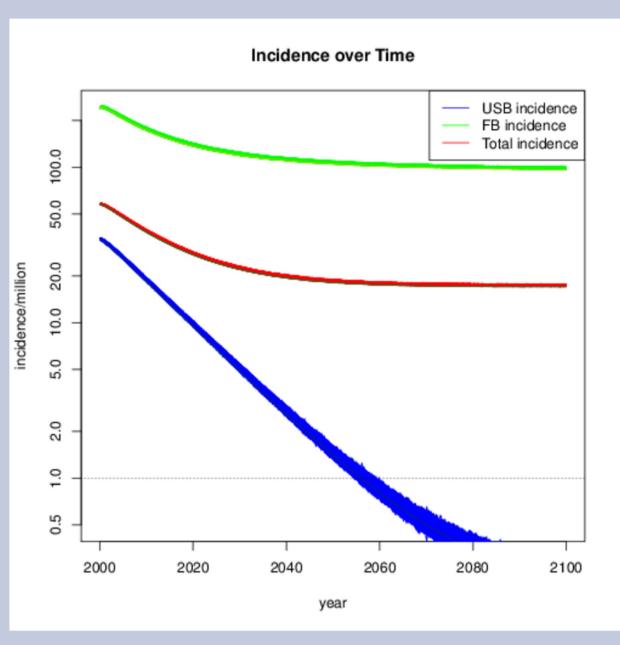
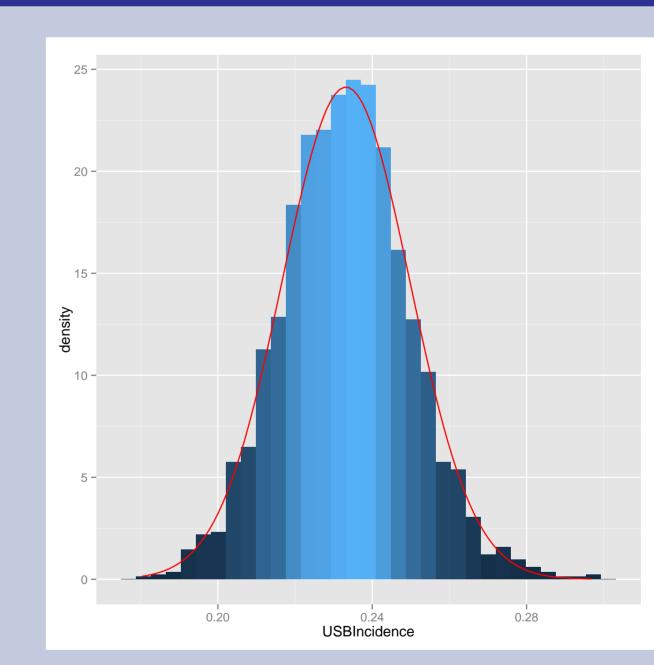
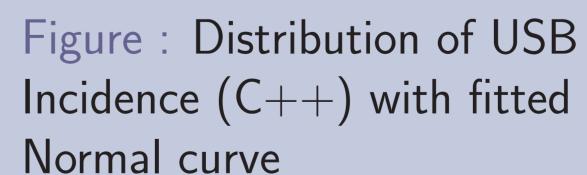


Figure : Incidence/million for R and C++ models (2100 runs,  $\Delta t = 0.01$ , popConst = 1)

## Stochastic Models as a Measure of Variability





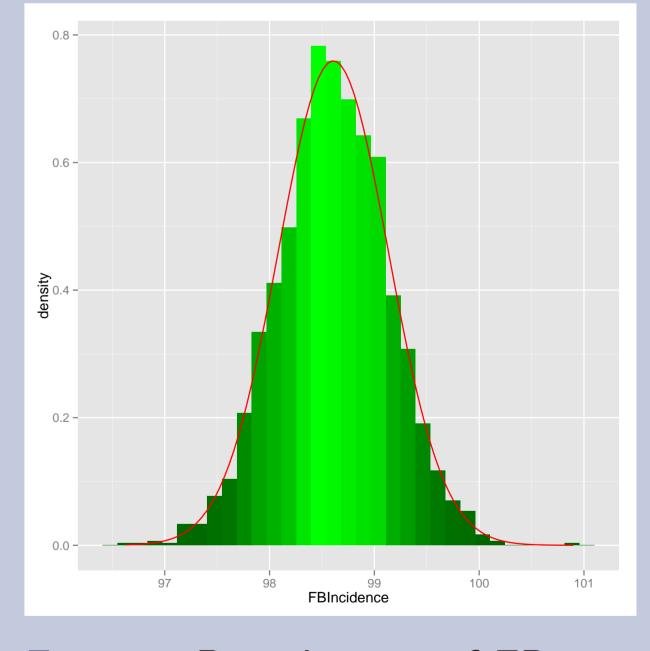


Figure: Distribution of FB Incidence (C++) with fitted Normal curve

#### References

Hill, A. N., Becerra, J. E., & Castro, K. G. (2012). Modelling tuberculosis trends in the USA. Epidemiology and infection, 140(10), 1862.