CDCT JHEEM Supplement

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1 Calibration Methods

The full calibration process for the Johns Hopkins Epidemiologic and Economic Model (JHEEM) is described elsewhere (SOURCE), but here, we perform an abridged calibration process that extends the parameters for the 1000 simulations produced for each state using the following reasoning.

Let θ_1 be the vector of all parameters calibrated previously and θ_2 be the two CDC-funded HIV testing related parameters to calibrate now. D_1 and D_2 correspond to the calibration targets for θ_1 and θ_2 respectively. To construct our likelihoods we assume:

$$p(\theta_1, \theta_2 | D_1, D_2) = p(\theta_2 | \theta_1, D_1, D_2) p(\theta_1 | D_1, D_2)$$

according to the law of total probability. We simplify this to:

$$p(\theta_2 | \theta_1, D_2) p(\theta_1 | D_1)$$

assuming

$$\theta_1 \perp D_2 | D_1$$

$$\theta_2 \perp D_1 | D_2, \theta_1$$

1.1 Calibration Targets

We calibrate our CDC HIV Testing related parameters to two calibration targets 1) CDC Funded HIV Testing Positivity from 2011-2019 for each state, and 2) Number of CDC Funded HIV Tests from 2011-2019 for each state (SOURCE). For the state of Mississippi, CDC Funded HIV Testing positivity is not included for the years 2011 and 2013 as a calibration target and the year 2020 is not included in the calibration because of the abnormal trends of the COVID-19 pandemic.

1.2 Testing Priors

We propose two parameters to be calibrated, 1) the proportion of CDC-funded tests and 2) the proportion of CDC-funded diagnoses. The former parameter's prior is based on national average data from 2019 (SOURCE) and is assumed to be constant across time and across risk groups. Error is sampled from log normal distribution with mean 0, standard deviation 0.2. The latter parameter's prior is informed by data from 2019-2021 and is assumed to follow a logit-linear function. Error is (α) sampled from log normal distribution with mean 0, standard deviation 0.2. The logit transformation of the proportion of cdc funded diagnoses is assumed to have a non linear relationship with time, and is modeled as a natural spline function with knots at years 2010, 2015 and 2020.

Proportion of CDC-funded tests

$$p_{cdc-tests} = \frac{\text{CDC Funded HIV Tests}}{\text{Total HIV Tests}} = \frac{2452507}{26427698} = 0.092800629$$

Proportion of CDC-funded diagnoses

$$p_{cdc-diagnoses} = \frac{\text{CDC Funded HIV Diagnoses}}{\text{Total HIV Diagnoses}} =$$

$$logit(\beta) = \beta_0 + \alpha_0 + \beta_{race} + \alpha_{race} + \beta_{age} + \alpha_{age} + \beta_{sex} + \alpha_{sex} + f(year)$$

1.3 Calibration

The distributional assumption of the likelihood for CDC HIV testing positvity is a binomial distribution and the distributional assumption of the likelihood for the number of CDC funded HIV tests is a poisson distribution. The joint likelihood is informed by combining these two corresponding multivariate normal distributions, in which a measurement error of both calibration targets is assumed (.015 for CDC funded HIV tests and 0.00015 for CDC HIV positivity).

Target 1 CDC HIV Positivity

$$pos_{cdc} = \frac{\text{CDC Funded HIV Diagnoses}}{\text{CDC Funded HIV Tests}} = \frac{p_{cdc-diagnoses}(\text{Total Diagnoses})}{p_{cdc-tests}(\text{Total Tests})}$$

Likelihood

$$y_{\text{cdc diagnoses}}\tilde{}Binomial(n = \text{cdc tests}, p = pos_{cdc})$$

Target 2: CDC Funded HIV Tests

Likelihood

$$y_{\text{cdc tests}}\tilde{}Poisson(np = \text{Total HIV Tests} * p_{cdc-tests})$$

2 Supplementary Figures

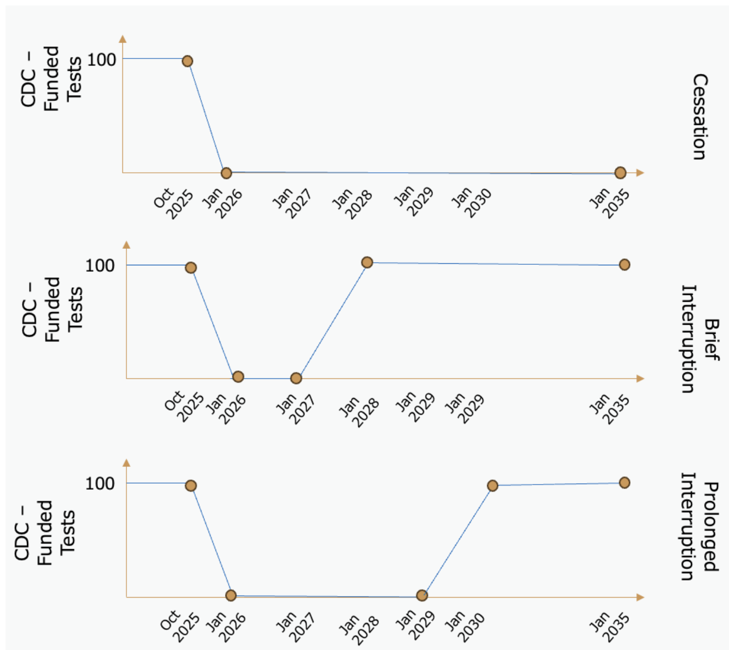

Figure 1: Schematic of CDC Testing Scenarios. The first panel describes the cessation intervention in which the CDC-funded testing is scaled down between October 2025- January 2026, and remains at this level until model projection ends in 2035. The second panel describes the brief interruption intervention in which the CDC-funded testing is scaled down between October 2025-January 2026 and returns from January 2027-January 2028. The last panel describes the prolonged interruption scenario in which CDC-funded testing is scaled down between October 2025- January 2026 and returns from January 2029-January 2030.

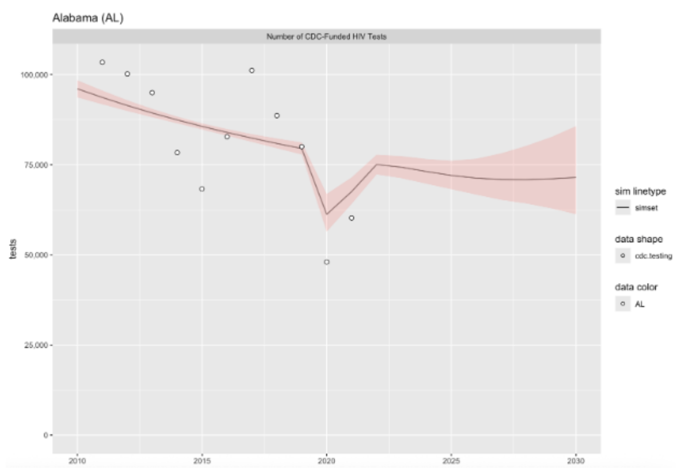

Figure 2: Calibration of model performance against number of CDC-Funded HIV tests for Alabama. The overlay of model simulations from the status quo simulation over time (x-axis) against the recorded number of CDC-funded HIV tests (y-axis) in Alabama is shown. White circles represent published data on the number of CDC-funded tests from 2011-2019. 2020 is excluded from historical trends due to the COVID-19 pandemic. The black line represents the average number of CDC-funded HIV tests across simulations, and the shaded red region represents all simulations.

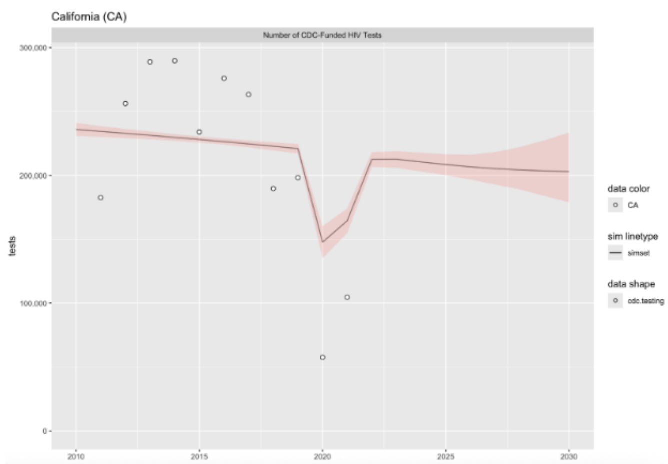

Figure 3: Calibration of model performance against number of CDC-Funded HIV tests for California. The overlay of model simulations from the status quo simulation over time (x-axis) against the recorded number of CDC-funded HIV tests (y-axis) in California is shown. White circles represent published data on the number of CDC-funded tests from 2011-2019. 2020 is excluded from historical trends due to the COVID-19 pandemic. The black line represents the average number of CDC-funded HIV tests across simulations, and the shaded red region represents all simulations.

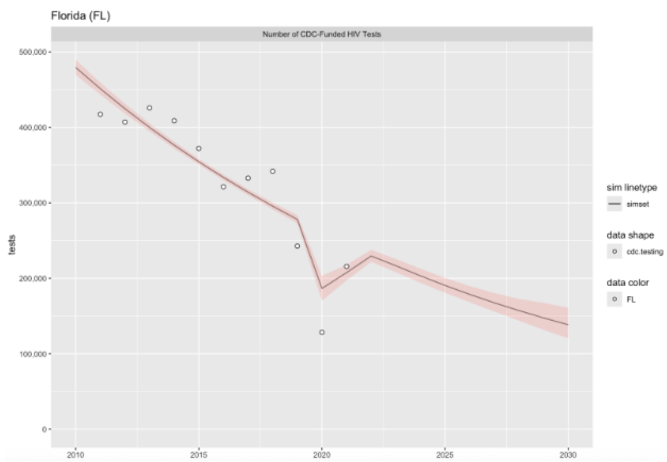

Figure 4: Calibration of model performance against number of CDC-Funded HIV tests for Florida. The overlay of model simulations from the status quo simulation over time (x-axis) against the recorded number of CDC-funded HIV tests (y-axis) in Florida is shown. White circles represent published data on the number of CDC-funded tests from 2011-2019. 2020 is excluded from historical trends due to the COVID-19 pandemic. The black line represents the average number of CDC-funded HIV tests across simulations, and the shaded red region represents all simulations.

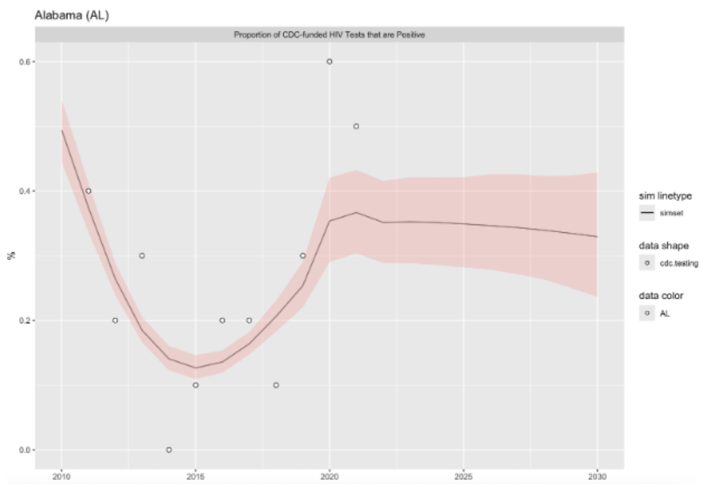

Figure 5: Calibration of model performance against CDC-funded HIV test positivity for Alabama. The overlay of model simulations from the status quo simulation over time (x-axis) against the recorded CDC-funded HIV test positivity (y-axis) in Alabama is shown. White circles represent published data on the number of CDC-funded tests from 2011-2019. 2020 is excluded from historical trends due to the COVID-19 pandemic. The black line represents the average number of CDC-funded HIV tests positivity across simulations, and the shaded red region represents all simulations.

Figure 6: Calibration of model performance against CDC-funded HIV test positivity for California. The overlay of model simulations from the status quo simulation over time (x-axis) against the recorded CDC-funded HIV test positivity (y-axis) in California is shown. White circles represent published data on the number of CDC-funded tests from 2011-2019. 2020 is excluded from historical trends due to the COVID-19 pandemic. The black line represents the average number of CDC-funded HIV tests positivity across simulations, and the shaded red region represents all simulations.

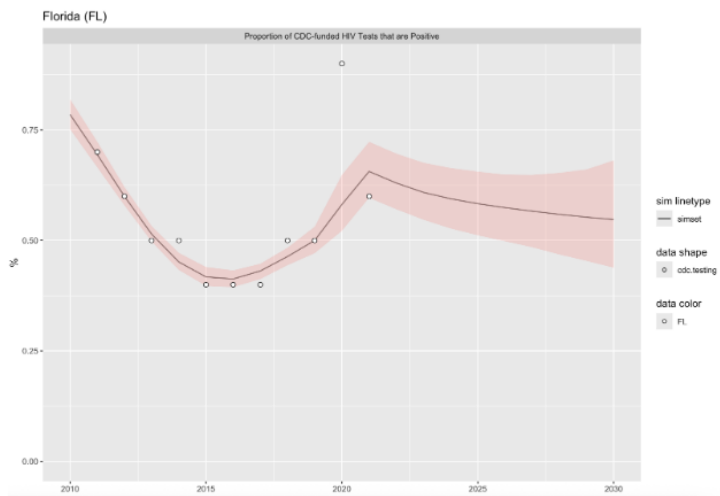

Figure 7: Calibration of model performance against CDC-funded HIV test positivity for Florida. The overlay of model simulations from the status quo simulation over time (x-axis) against the recorded CDC-funded HIV test positivity (y-axis) in Florida is shown. White circles represent published data on the number of CDC-funded tests from 2011-2019. 2020 is excluded from historical trends due to the COVID-19 pandemic. The black line represents the average number of CDC-funded HIV tests positivity across simulations, and the shaded red region represents all simulations.

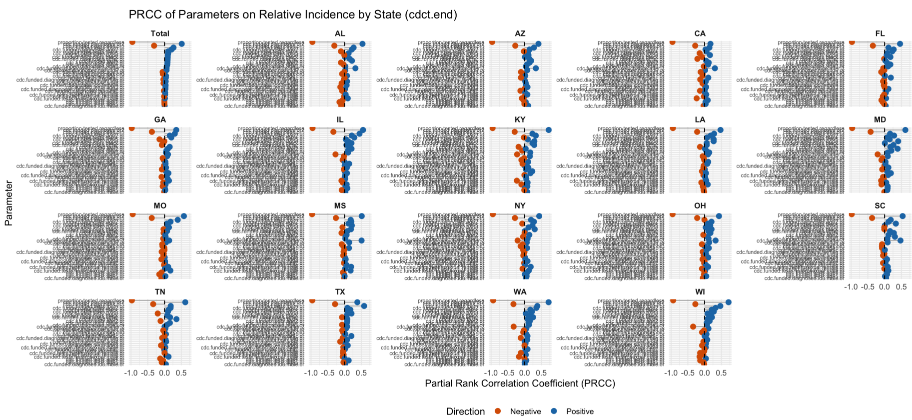

Figure 8: Impact of sampled CDC testing related parameters on relative excess incidence of HIV. The spearman's partial rank correlation coefficient (PRCC) (x-axis) for each of the 35 parameters governing CDC testing in our model is calculated, in comparison to the relative excess incidence of HIV comparing the cessation intervention with the status quo intervention (y-axis). This PRCC is calculated for each of the 11 states' 1000 simulations, and is denoted in red if the correlation is negative and blue if the correlation is positive. The first panel denotes the average PRCC for each parameter across all 18 states.

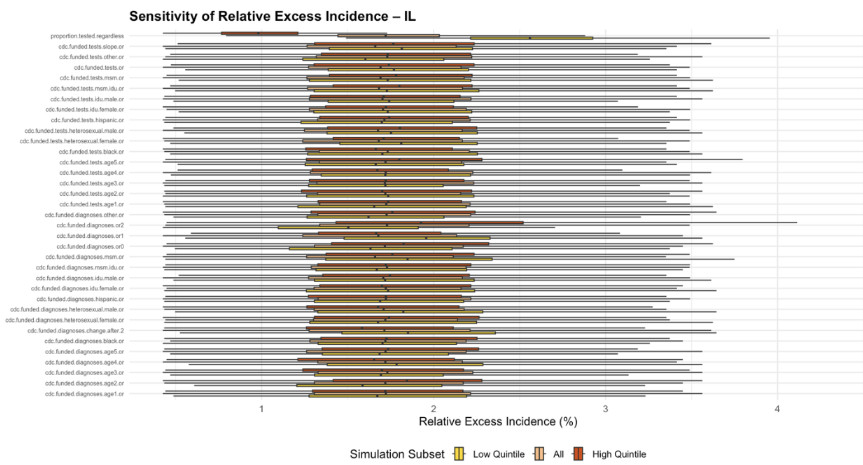

Figure 9: Sensitivity analyses for Illinois. On the x-axis we report the relative excess difference of HIV between the cessation intervention with the status quo intervention for the state of Illinois. Yellow bars show the distribution of outcomes among simulations for which the specified parameter is in the lowest quintile of its sampled values (out of 1000 simulations), and dark orange bars show the distribution of outcomes among simulations for which the specified parameter is in the highest quintile of its sampled values. The distribution of outcomes across all parameter values are shown in light orange. All distributions are represented as boxplots, with the endpoints of the colored bars indicating the interquartile range (IQR) and the error bars indicate the highest and lowest values no more than 1.5*IQR from the ends of the bars. Parameters are ordered from highest to lowest spearman's partial rank correlation coefficient.

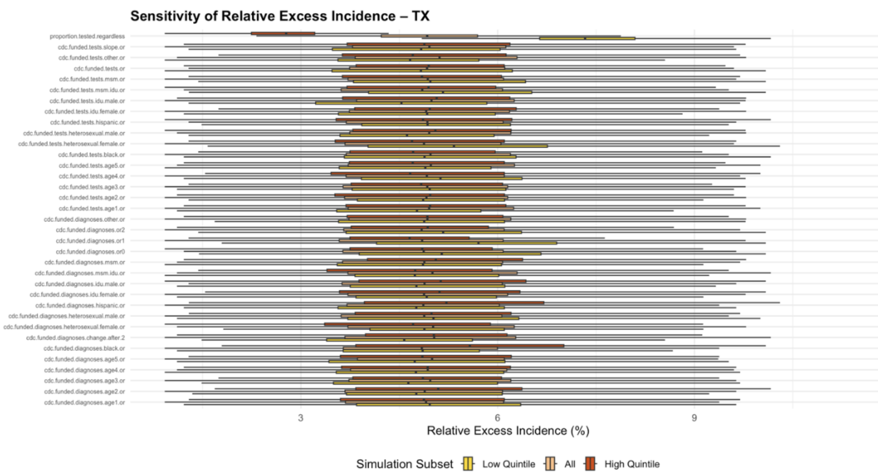

Figure 10: Sensitivity analyses for Texas. On the x-axis we report the relative excess difference of HIV between the cessation intervention with the status quo intervention for the state of Texas. Yellow bars show the distribution of outcomes among simulations for which the specified parameter is in the lowest quintile of its sampled values (out of 1000 simulations), and dark orange bars show the distribution of outcomes among simulations for which the specified parameter is in the highest quintile of its sampled values. The distribution of outcomes across all parameter values are shown in light orange. All distributions are represented as boxplots, with the endpoints of the colored bars indicating the interquartile range (IQR) and the error bars indicate the highest and lowest values no more than 1.5*IQR from the ends of the bars. Parameters are ordered from highest to lowest spearman's partial rank correlation coefficient.

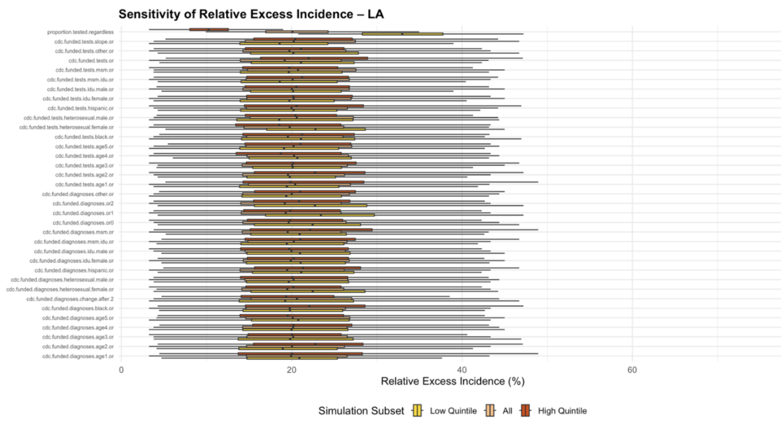

Figure 11: Sensitivity analyses for Louisiana. On the x-axis we report the relative excess difference of HIV between the cessation intervention with the status quo intervention for the state of Louisiana. Yellow bars show the distribution of outcomes among simulations for which the specified parameter is in the lowest quintile of its sampled values (out of 1000 simulations), and dark orange bars show the distribution of outcomes among simulations for which the specified parameter is in the highest quintile of its sampled values. The distribution of outcomes across all parameter values are shown in light orange. All distributions are represented as boxplots, with the endpoints of the colored bars indicating the interquartile range (IQR) and the error bars indicate the highest and lowest values no more than 1.5*IQR from the ends of the bars. Parameters are ordered from highest to lowest spearman's partial rank correlation coefficient.