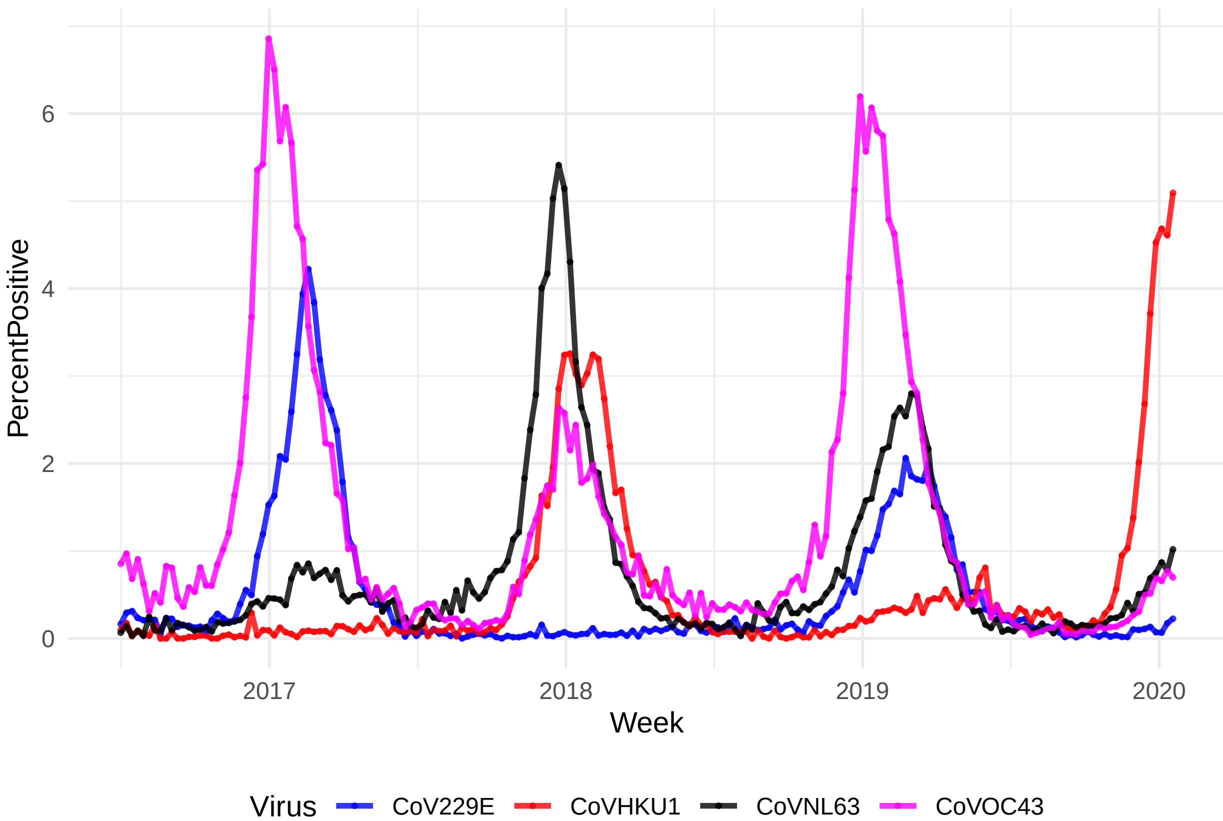
Coronavirus seasonality

Introduction

The goal of this work is to describe how the effective reproduction number (R_E) for coronavirus evolves seasonally, and then to understand the factors underlying these changes, including depletion of susceptibles, weather patterns, school closures, etc. Eventually, we may be interested in looking at R_E by subtype, age group, compare percentage of positive tests to raw number of positive tests, etc.

The following figure (data compilation and code by Stephen Kissler) shows the seasonal trends in positive tests for four different coronavirus strains in the United States from July 2016 to January 2020 (NREVSS):



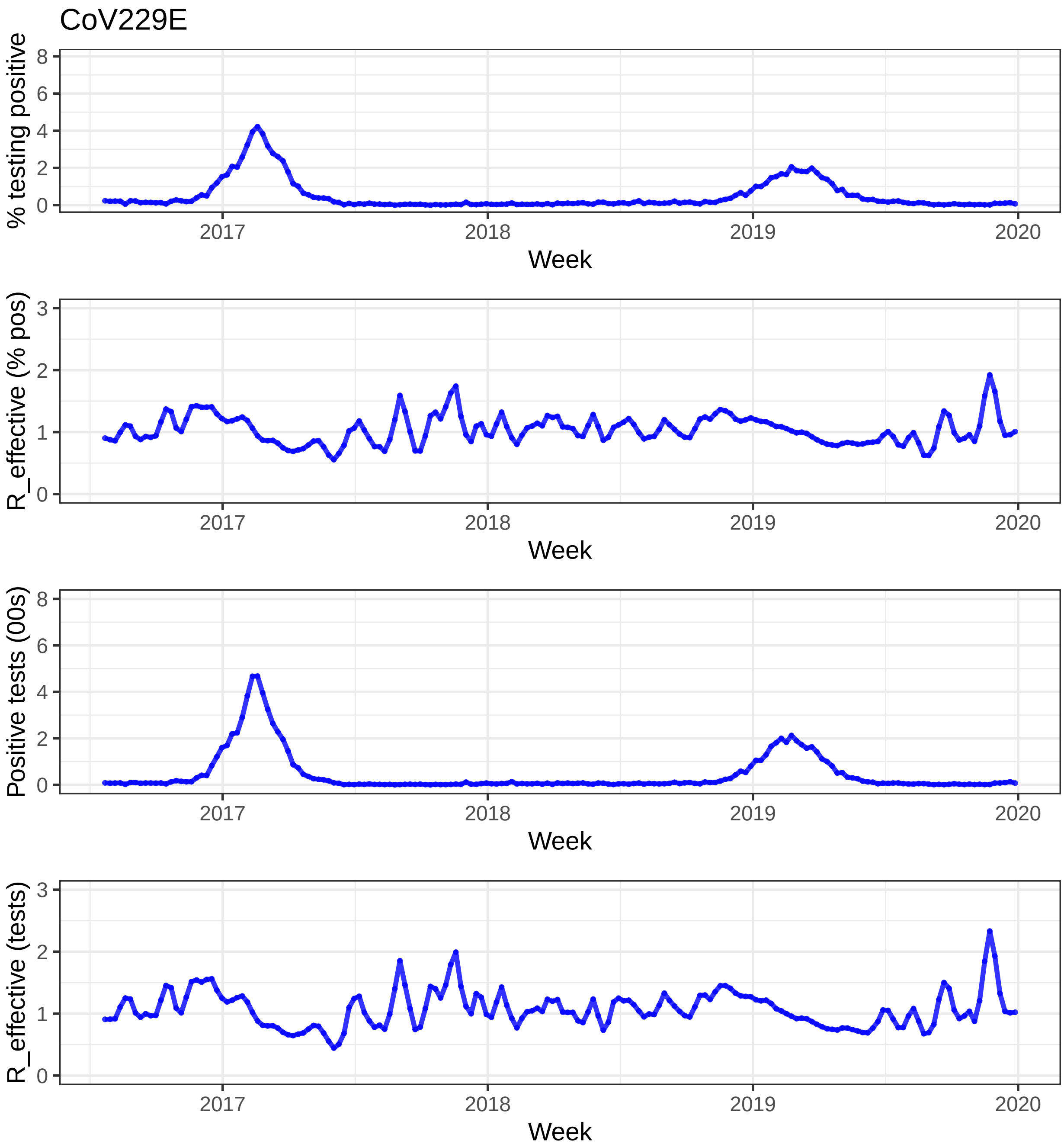
Methods

We use the Wallinga-Teunis (Wallinga & Teunis, AJE 2004) method to estimate the weekly R_E from time series data of the proportion and number of positive tests for each coronavirus strain. The method described by te Beest, et al. (AJE 2013) was used to translate weekly data into daily values to be used with the Wallinga-Teunis method. The weekly R_E estimates are the geometric mean of the daily R_E estimates. For smoothing purposes, the estimates shown are the 3-week moving geometric mean (geometric mean over daily values from the current week, week before, and week after). Code from te Beest, et al. was adapted for this analysis.

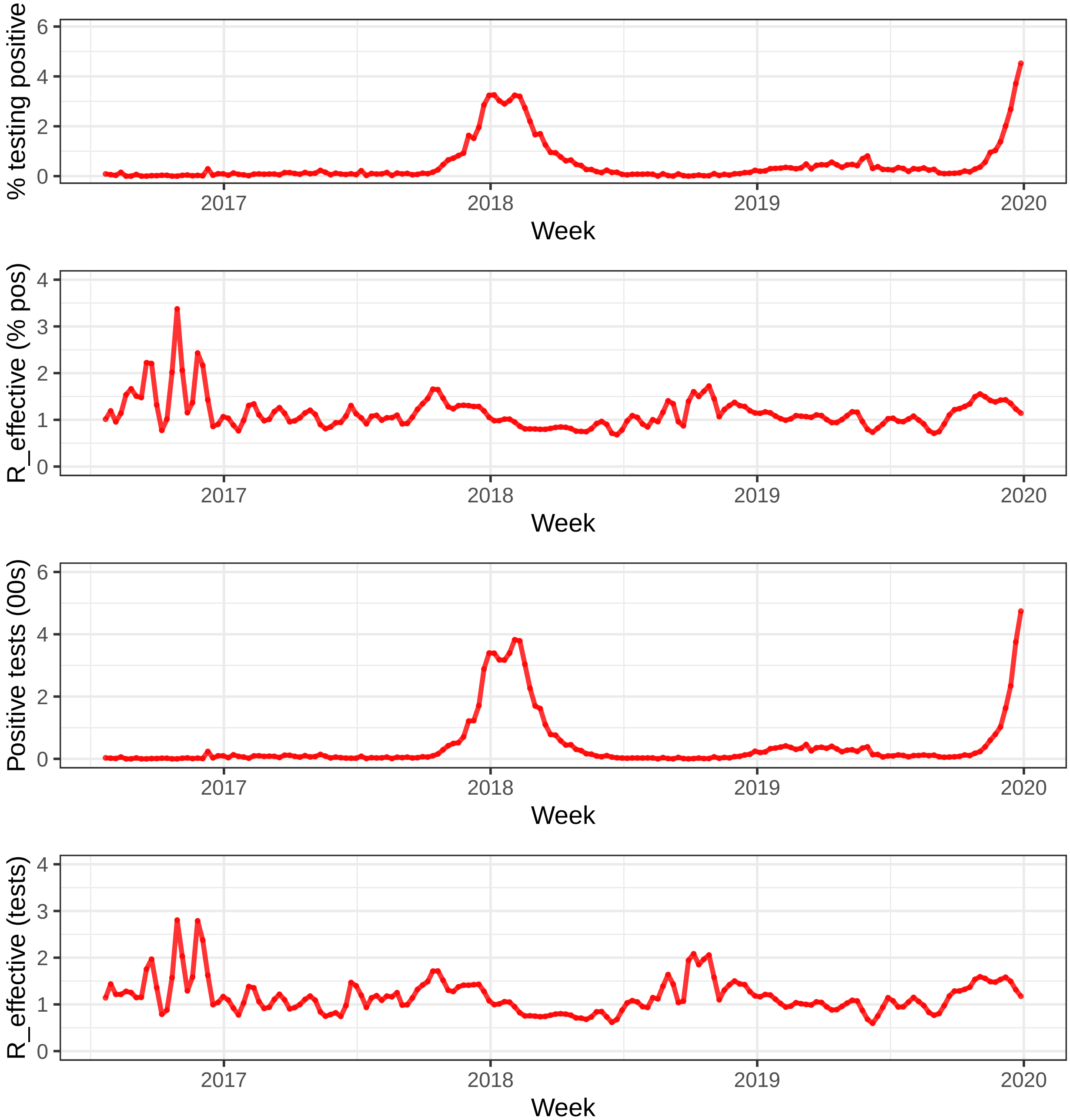
Assumptions:

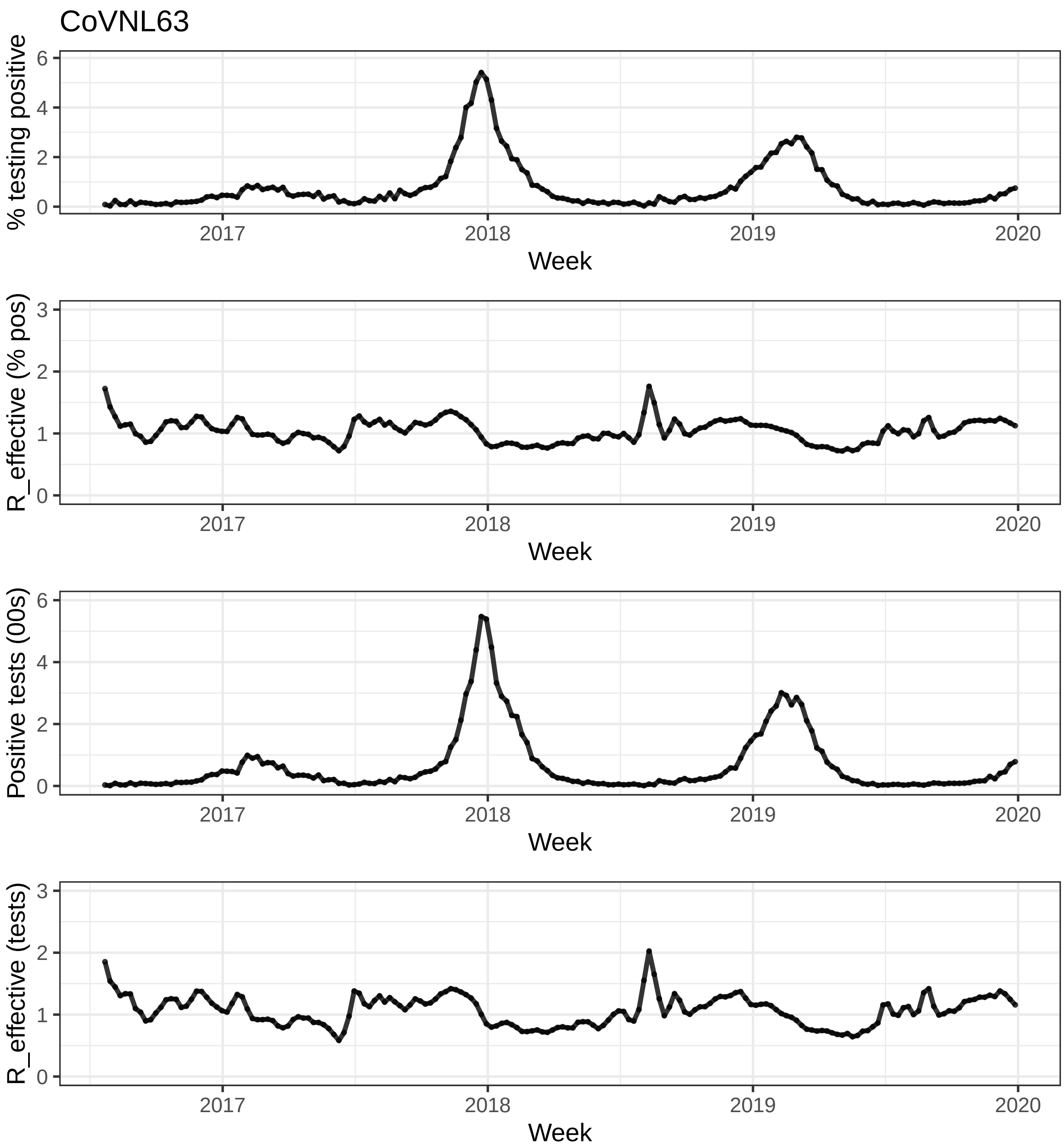
- *Raw number of positive tests*: The weekly number of positive tests was estimated by multiplying the proportion of tests that were positive for each strain (shown above) by the total number of tests recorded in NREVSS (Killerby, et al. J Clin Virol 2018). Data from Killerby, et al. ranges from July 2014 to June 2017, overlapping our %-positive data by one year. Total test numbers from the year of overlap (July 2016-June 2017) were used as estimates of the raw number of positive tests for all years of %-positive data.
- *Serial interval*: We use the serial interval observed during the SARS outbreak in Singapore - a Weibull distribution with shape parameter α and scale parameter β corresponding to mean interval of 8.4 days and standard deviation of 3.8 days (Wallinga & Teunis, AJE 2004). We set the maximum serial interval to 19 days, the 99.4th percentile of this distribution.
- *Estimating daily values from weekly data*: A spline method described in te Beest, et al. was used to estimate daily numbers of positive tests while keeping the weekly total consistent with the observed data. For the proportion of positive tests, the weekly value was used as the daily value for each day of that week.

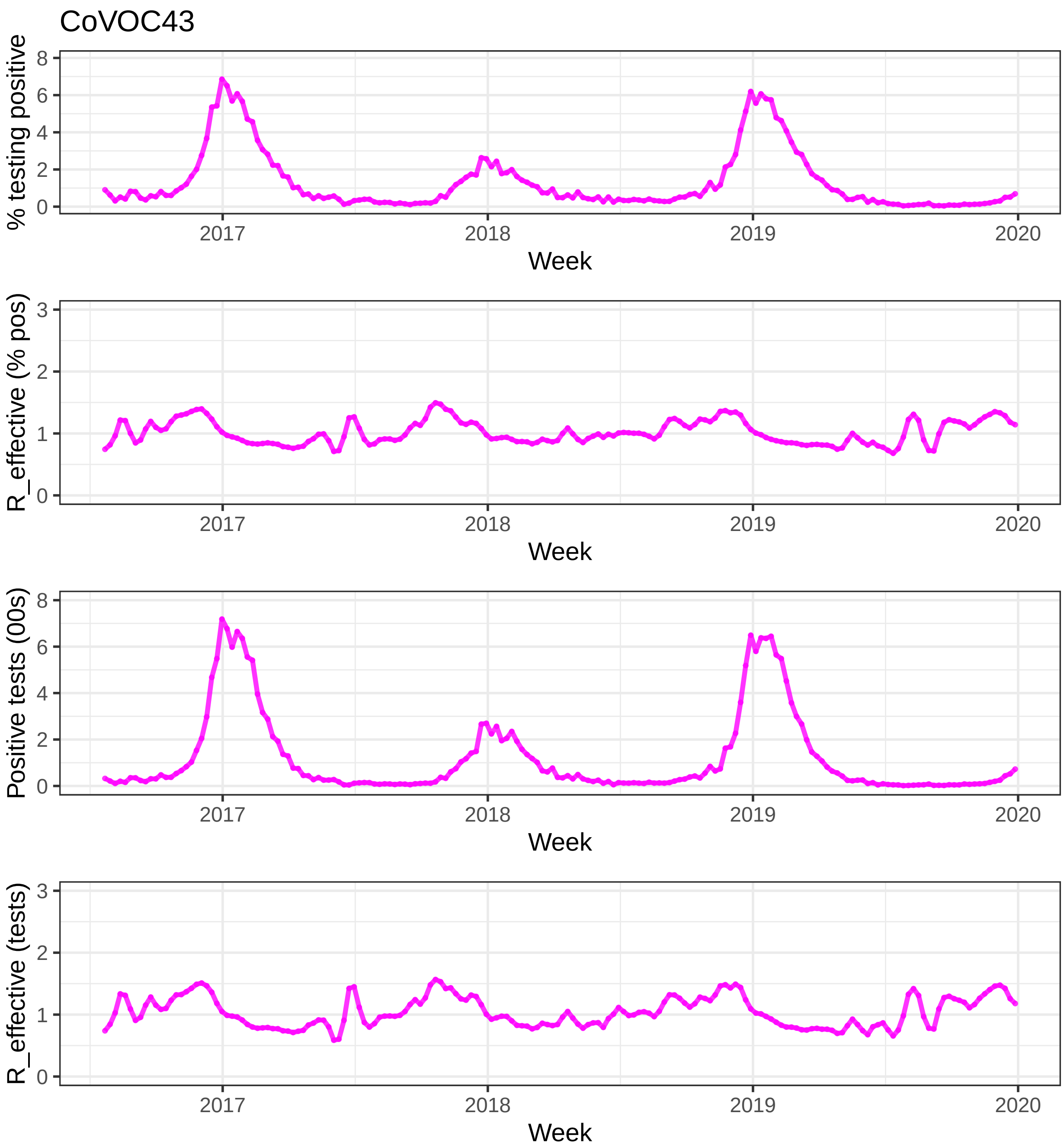
Estimation of R_E in the US



CoVHKU1


% testing positive
R_effective (% pos)
Positive tests (00s)
R_effective (tests)
Week
2017
2018
2019
2020


CoVNL63
% testing positive
R_effective (% pos)
Positive tests (00s)
R_effective (tests)
Week
2017
2018
2019
2020
0
1
2
3
4
6



CoVOC43
% testing positive
R_effective (% pos)
Positive tests (00s)
R_effective (tests)
Week
2017
2018
2019
2020