Covid-19 exploratory analysis

Saurajyoti Kar 4/8/2020

```
library(tidyverse)
## -- Attaching packages -----
                                      ----- tidyverse 1.3.0 --
## v ggplot2 3.2.1
                     v purrr
                                 0.3.3
## v tibble 2.1.3 v dplyr 0.8.3
## v tidyr 1.0.0 v stringr 1.4.0
## v readr
           1.3.1
                     v forcats 0.4.0
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()
                    masks stats::lag()
library(reshape2)
##
## Attaching package: 'reshape2'
## The following object is masked from 'package:tidyr':
##
##
       smiths
library(doParallel)
## Loading required package: foreach
##
## Attaching package: 'foreach'
## The following objects are masked from 'package:purrr':
##
##
       accumulate, when
## Loading required package: iterators
## Loading required package: parallel
path <- '/Users/saurajyotikar/Documents/git_startup/COVID-19/csse_covid_19_data/csse_covid_19_time_seri
setwd(path)
fname_usa <- 'time_series_covid19_confirmed_US.csv'</pre>
fname_glo <- 'time_series_covid19_confirmed_global.csv'</pre>
d_usa <- read_csv(fname_usa)</pre>
## Parsed with column specification:
## cols(
##
     .default = col_double(),
##
     iso2 = col_character(),
##
     iso3 = col_character(),
##
     Admin2 = col_character(),
     Province_State = col_character(),
##
     Country_Region = col_character(),
```

##

)

Combined_Key = col_character()

```
## See spec(...) for full column specifications.
d_glo <- read_csv(fname_glo)</pre>
## Parsed with column specification:
## cols(
##
     .default = col_double(),
##
     `Province/State` = col_character(),
     `Country/Region` = col_character()
##
## )
## See spec(...) for full column specifications.
d usa
## # A tibble: 3,253 x 91
##
         UID iso2 iso3 code3 FIPS Admin2 Province State Country Region
                                                                              Lat
       <dbl> <chr> <dbl> <dbl> <chr> <dbl> <dbl> <chr> <
                                                             <chr>
                                                                            <dbl>
   1 1.60e1 AS
##
                            16
                                   60 <NA>
                                                                            -14.3
                   ASM
                                             American Samoa US
##
   2 3.16e2 GU
                   GUM
                           316
                                   66 <NA>
                                             Guam
                                                            US
                                                                             13.4
##
  3 5.80e2 MP
                   MNP
                           580
                                   69 <NA>
                                             Northern Mari~
                                                            US
                                                                             15.1
  4 6.30e2 PR
                   PRI
                           630
                                  72 <NA>
                                             Puerto Rico
                                                            US
                                                                             18.2
## 5 8.50e2 VI
                           850
                                  78 <NA>
                   VIR
                                             Virgin Islands US
                                                                             18.3
                               1001 Autau~ Alabama
##
   6 8.40e7 US
                   USA
                           840
                                                            US
                                                                             32.5
##
  7 8.40e7 US
                   USA
                           840
                               1003 Baldw~ Alabama
                                                            US
                                                                             30.7
                           840 1005 Barbo~ Alabama
  8 8.40e7 US
                                                            US
                                                                             31.9
##
                   USA
##
   9 8.40e7 US
                   USA
                           840 1007 Bibb
                                             Alabama
                                                            US
                                                                             33.0
## 10 8.40e7 US
                   USA
                           840 1009 Blount Alabama
                                                            US
                                                                             34.0
## # ... with 3,243 more rows, and 82 more variables: Long <dbl>,
       Combined_Key <chr>, `1/22/20` <dbl>, `1/23/20` <dbl>, `1/24/20` <dbl>,
## #
       `1/25/20` <dbl>, `1/26/20` <dbl>, `1/27/20` <dbl>, `1/28/20` <dbl>,
## #
       `1/29/20` <dbl>, `1/30/20` <dbl>, `1/31/20` <dbl>, `2/1/20` <dbl>,
       `2/2/20` <dbl>, `2/3/20` <dbl>, `2/4/20` <dbl>, `2/5/20` <dbl>,
       `2/6/20` <dbl>, `2/7/20` <dbl>, `2/8/20` <dbl>, `2/9/20` <dbl>,
## #
       `2/10/20` <dbl>, `2/11/20` <dbl>, `2/12/20` <dbl>, `2/13/20` <dbl>,
## #
## #
       `2/14/20` <dbl>, `2/15/20` <dbl>, `2/16/20` <dbl>, `2/17/20` <dbl>,
       `2/18/20` <dbl>, `2/19/20` <dbl>, `2/20/20` <dbl>, `2/21/20` <dbl>,
       `2/22/20` <dbl>, `2/23/20` <dbl>, `2/24/20` <dbl>, `2/25/20` <dbl>,
## #
## #
       `2/26/20` <dbl>, `2/27/20` <dbl>, `2/28/20` <dbl>, `2/29/20` <dbl>,
       `3/1/20` <dbl>, `3/2/20` <dbl>, `3/3/20` <dbl>, `3/4/20` <dbl>,
## #
       `3/5/20` <dbl>, `3/6/20` <dbl>, `3/7/20` <dbl>, `3/8/20` <dbl>,
## #
       `3/9/20` <dbl>, `3/10/20` <dbl>, `3/11/20` <dbl>, `3/12/20` <dbl>,
## #
## #
       `3/13/20` <dbl>, `3/14/20` <dbl>, `3/15/20` <dbl>, `3/16/20` <dbl>,
## #
       `3/17/20` <dbl>, `3/18/20` <dbl>, `3/19/20` <dbl>, `3/20/20` <dbl>,
## #
       `3/21/20` <dbl>, `3/22/20` <dbl>, `3/23/20` <dbl>, `3/24/20` <dbl>,
       `3/25/20` <dbl>, `3/26/20` <dbl>, `3/27/20` <dbl>, `3/28/20` <dbl>,
## #
## #
       `3/29/20` <dbl>, `3/30/20` <dbl>, `3/31/20` <dbl>, `4/1/20` <dbl>,
## #
       `4/2/20` <dbl>, `4/3/20` <dbl>, `4/4/20` <dbl>, `4/5/20` <dbl>,
       `4/6/20` <dbl>, `4/7/20` <dbl>, `4/8/20` <dbl>, `4/9/20` <dbl>,
## #
## #
       `4/10/20` <dbl>
d_glo
## # A tibble: 264 x 84
                                                 Long `1/22/20` `1/23/20` `1/24/20`
      `Province/State` `Country/Region`
                                           Lat
##
                                                                     <dbl>
                                                                               <dbl>
      <chr>
                       <chr>
                                         <dbl>
                                                <dbl>
                                                          <dbl>
##
   1 <NA>
                       Afghanistan
                                          33
                                                65
```

```
##
   2 <NA>
                       Albania
                                          41.2 20.2
                                                              0
                                                                        0
##
   3 <NA>
                                         28.0
                                                 1.66
                                                              0
                                                                        0
                                                                                   0
                       Algeria
##
  4 <NA>
                       Andorra
                                         42.5
                                                 1.52
                                                              0
                                                                        0
                                                                                   0
                                                                        0
##
  5 <NA>
                                         -11.2 17.9
                                                              0
                                                                                   0
                       Angola
##
   6 <NA>
                       Antigua and Bar~ 17.1 -61.8
                                                              0
                                                                        0
                                                                                   0
                                                              0
                                                                        0
                                                                                   0
##
  7 <NA>
                       Argentina
                                        -38.4 -63.6
                                                                        0
##
   8 <NA>
                       Armenia
                                         40.1 45.0
                                                              0
   9 Australian Capi~ Australia
##
                                         -35.5 149.
                                                              0
                                                                        0
                                                                                   0
## 10 New South Wales Australia
                                         -33.9 151.
                                                              0
                                                                        0
                                                                                   0
    ... with 254 more rows, and 77 more variables: `1/25/20` <dbl>,
       `1/26/20` <dbl>, `1/27/20` <dbl>, `1/28/20` <dbl>, `1/29/20` <dbl>,
       `1/30/20` <dbl>, `1/31/20` <dbl>, `2/1/20` <dbl>, `2/2/20` <dbl>,
## #
       `2/3/20` <dbl>, `2/4/20` <dbl>, `2/5/20` <dbl>, `2/6/20` <dbl>,
## #
       `2/7/20` <dbl>, `2/8/20` <dbl>, `2/9/20` <dbl>, `2/10/20` <dbl>,
## #
## #
       `2/11/20` <dbl>, `2/12/20` <dbl>, `2/13/20` <dbl>, `2/14/20` <dbl>,
       `2/15/20` <dbl>, `2/16/20` <dbl>, `2/17/20` <dbl>, `2/18/20` <dbl>,
## #
       `2/19/20` <dbl>, `2/20/20` <dbl>, `2/21/20` <dbl>, `2/22/20` <dbl>,
## #
## #
       ^2/23/20` <dbl>, ^2/24/20` <dbl>, ^2/25/20` <dbl>, ^2/26/20` <dbl>,
       `2/27/20` <dbl>, `2/28/20` <dbl>, `2/29/20` <dbl>, `3/1/20` <dbl>,
## #
       `3/2/20` <dbl>, `3/3/20` <dbl>, `3/4/20` <dbl>, `3/5/20` <dbl>,
## #
## #
       `3/6/20` <dbl>, `3/7/20` <dbl>, `3/8/20` <dbl>, `3/9/20` <dbl>,
       `3/10/20` <dbl>, `3/11/20` <dbl>, `3/12/20` <dbl>, `3/13/20` <dbl>,
## #
       `3/14/20` <dbl>, `3/15/20` <dbl>, `3/16/20` <dbl>, `3/17/20` <dbl>,
## #
       `3/18/20` <dbl>, `3/19/20` <dbl>, `3/20/20` <dbl>, `3/21/20` <dbl>,
## #
## #
       ~3/22/20~ <dbl>, ~3/23/20~ <dbl>, ~3/24/20~ <dbl>, ~3/25/20~ <dbl>,
       `3/26/20` <dbl>, `3/27/20` <dbl>, `3/28/20` <dbl>, `3/29/20` <dbl>,
## #
       `3/30/20` <dbl>, `3/31/20` <dbl>, `4/1/20` <dbl>, `4/2/20` <dbl>,
       `4/3/20` <dbl>, `4/4/20` <dbl>, `4/5/20` <dbl>, `4/6/20` <dbl>,
## #
       `4/7/20` <dbl>, `4/8/20` <dbl>, `4/9/20` <dbl>, `4/10/20` <dbl>
## #
d1_usa <- d_usa %>% pivot_longer(
     cols = 12:ncol(d_usa),
     names_pattern = (.*)/*',
     names_to = "dated",
     values_to = "cases_confirmed",
     values_drop_na = F
#view(d1_usa)
d2_usa <- d1_usa %>%
  group_by(dated) %>%
  summarise(n_cases_confirmed=sum(cases_confirmed)) %>%
  mutate(dated = as.Date(dated, format="%m/%d/%y")) %>%
  ungroup()
d2_usa
## # A tibble: 80 x 2
##
      dated
                 n_cases_confirmed
                             <dbl>
##
      <dat.e>
   1 2020-01-22
##
                                  1
   2 2020-01-23
                                  1
##
                                 2
##
   3 2020-01-24
  4 2020-01-25
                                 2
## 5 2020-01-26
                                 5
```

```
## 6 2020-01-27
## 7 2020-01-28
                                   5
## 8 2020-01-29
                                    5
## 9 2020-01-30
                                   5
                                   7
## 10 2020-01-31
## # ... with 70 more rows
ggplot(d2_usa, aes(dated, n_cases_confirmed)) +
  geom line() +
  xlab('Recorded dates') +
  scale_y_continuous('Number of confirmed cases (all US)') +
  theme_minimal()
  5e+05
  4e+05
Number of confirmed cases (all US)
  1e+05
  0e+00
                   Feb 01
                                  Feb 15
                                                 Mar 01
                                                                                  Apr 01
                                                                Mar 15
                                              Recorded dates
d3_usa <- d1_usa %>%
  group_by(Province_State, dated) %>%
  summarise(n_cases_confirmed=sum(cases_confirmed)) %>%
  mutate(dated = as.Date(dated, "%m/%d/%y")) %>%
  ungroup()
# ordering the provinces on number of confirmed cases, descending
province_order_desc <- d3_usa %>%
  filter(dated==max(dated)) %>%
  arrange(desc(n_cases_confirmed)) %>%
  select(Province_State) %>%
  c()
d3_usa <- d3_usa %>%
  mutate(Province_State =
            fct_relevel(Province_State,
```

levels = c(province_order_desc)))

```
## Warning: Outer names are only allowed for unnamed scalar atomic inputs
ggplot(d3_usa, aes(dated, n_cases_confirmed, colour = Province_State)) +
  geom_line() +
  scale_x_date('Recorded dates',
                 breaks = function(x) seq.Date(from = min(x),
                                                   by = "1 week")) +
  scale y continuous('Number of confirmed cases (by US province)',
                       breaks = function (x) round(seq.int(from = min(x),
                                    to = max(x),
                                   length.out = 10))) +
  theme_minimal() +
  theme(legend.position = "bottom",
         legend.title = element_blank()) +
  guides(col = guide_legend(nrow = 6))
  180965
(a) 159901

138836

S) 117771

96706

75642

54577

33517

1244
    Recorded dates
              — Washington — Virginia

    Alabama

    Kentucky

                                                                - Oregon
   Louisiana

    Vermont

                                                                                         Montana
              — Marvland — North Carolina — Nevada

    District of Columbia
    Arkansas

    Nebraska

                                                                                       — North Dakota
   — Illinois
                                     — Mississippi
    — Florida
              — Indiana
                        — Missouri
                                                 lowa
                                                              Kansas
                                                                            Maine
                                                                                       Alaska
              — Colorado — Arizona
                                     Utah
                                                Idaho
                                                               New Mexico
                                                                           - West Virginia - Wyoming
setts - Georgia
              — Ohio
                        Wisconsin
                                     Oklahoma
                                                Minnesota
                                                               New Hampshire — South Dakota — Guam
nia — Connecticut — Tennessee — South Carolina — Rhode Island — Delaware
                                                               — Puerto Rico
                                                                           Hawaii

    Grand Princess

d4_usa <- d3_usa %>%
  filter(!Province_State %in% c('New York'))
ggplot(d4_usa, aes(dated, n_cases_confirmed, colour = Province_State)) +
  geom_line() +
  scale_x_date('Recorded dates',
                 breaks = function(x) seq.Date(from = min(x),
                                                   to = max(x),
                                                   by = "1 week")) +
  scale_y_continuous('Number of confirmed cases (by US province)',
                       breaks = function (x) round(seq.int(from = min(x),
                                   to = max(x),
                                   length.out = 10))) +
  theme minimal() +
  theme(legend.position = "bottom",
```

```
legend.title = element_blank()) +
     guides(col = guide_legend(nrow = 6))
      57317
(a) 50646 (b) 143974 (c) 243974 (
       -2729 -2020-01-18 2020-01-25 2020-02-01 2020-02-08 2020-02-15 2020-02-22 2020-02-29 2020-03-07 2020-03-14 2020-03-21 2020-03-28 2020-04-04 2020-04-11
                                                                                                                          Recorded dates

    District of Columbia — Arkansas

         Illinois

    Maryland

                                                           — North Carolina -
                                                                                                   Nevada
                                                                                                                                                                                                      Nebraska
                                                                                                                                                                                                                                    North Dakota
         — Florida
                                         Indiana

    Missouri

                                                                                                   Mississippi
                                                                                                                                Iowa
                                                                                                                                                                 Kansas
                                                                                                                                                                                                      Maine
                                                                                                                                                                                                                                    Alaska
                                          Colorado
                                                                   Arizona
                                                                                                   Utah
                                                                                                                               Idaho
                                                                                                                                                                      New Mexico
                                                                                                                                                                                                      West Virginia
                                                                                                                                                                                                                                    Wyoming

    Wisconsin

                                                                                                   Oklahoma
                                                                                                                              Minnesota
                                                                                                                                                                     New Hampshire
                                                                                                                                                                                                      South Dakota
                                                                                                                                                                                                                                   Guam
               Georgia

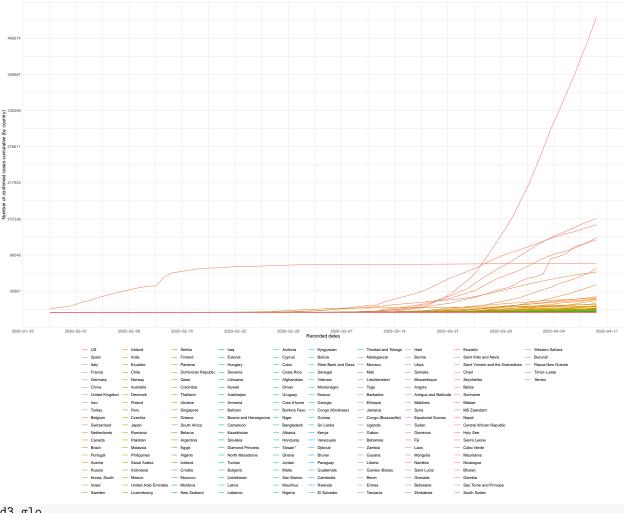
    Delaware

                                         Tennessee — South Carolina -
                                                                                                   Rhode Island
                                                                                                                                                                      Puerto Rico
                                                                                                                                                                                                      Hawaii

    Grand Princess

               Connecticut ---
         — Washington — Virginia
                                                          — Alabama
                                                                                                                                                                                                                             Virgin Islands
                                                                                                   Kentucky
                                                                                                                               Oregon
                                                                                                                                                                      Vermont
                                                                                                                                                                                                      Montana
d1_glo <- d_glo %>% pivot_longer(
              cols = 12:ncol(d_glo),
              names_pattern = '(.*)/*',
              names_to = "dated",
              values_to = "cases_confirmed",
              values_drop_na = F
  )
d1_glo
## # A tibble: 19,272 x 13
                  `Province/State` `Country/Region`
                                                                                                                                  Long `1/22/20` `1/23/20` `1/24/20`
##
                                                                                                                       Lat
##
                 <chr>
                                                                  <chr>
                                                                                                                   <dbl> <dbl>
                                                                                                                                                                 <dbl>
                                                                                                                                                                                             <dbl>
                                                                                                                                                                                                                          <dbl>
##
           1 <NA>
                                                                  Afghanistan
                                                                                                                          33
                                                                                                                                            65
                                                                                                                                                                           0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                    0
           2 <NA>
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                    0
##
                                                                  Afghanistan
                                                                                                                           33
                                                                                                                                            65
                                                                                                                                                                           0
                                                                                                                           33
##
           3 <NA>
                                                                  Afghanistan
                                                                                                                                            65
                                                                                                                                                                            0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                     0
##
           4 <NA>
                                                                  Afghanistan
                                                                                                                           33
                                                                                                                                            65
                                                                                                                                                                            0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                     0
           5 <NA>
                                                                                                                           33
                                                                                                                                                                                                        0
##
                                                                  Afghanistan
                                                                                                                                            65
                                                                                                                                                                            0
                                                                                                                                                                                                                                     0
##
           6 <NA>
                                                                  Afghanistan
                                                                                                                           33
                                                                                                                                            65
                                                                                                                                                                           0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                     0
                                                                                                                           33
##
           7 <NA>
                                                                  Afghanistan
                                                                                                                                            65
                                                                                                                                                                           0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                     0
##
           8 <NA>
                                                                  Afghanistan
                                                                                                                           33
                                                                                                                                            65
                                                                                                                                                                           0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                     0
##
           9 <NA>
                                                                                                                           33
                                                                                                                                            65
                                                                                                                                                                           0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                     0
                                                                  Afghanistan
## 10 <NA>
                                                                 Afghanistan
                                                                                                                           33
                                                                                                                                            65
                                                                                                                                                                            0
                                                                                                                                                                                                        0
                                                                                                                                                                                                                                     0
## # ... with 19,262 more rows, and 6 more variables: `1/25/20` <dbl>,
                   `1/26/20` <dbl>, `1/27/20` <dbl>, `1/28/20` <dbl>, dated <chr>,
## #
                   cases_confirmed <dbl>
d2_glo <- d1_glo %>%
     group_by(`Country/Region`, dated) %>%
```

```
summarise(n_cases_confirmed=sum(cases_confirmed)) %>%
  mutate(dated = as.Date(dated, format="%m/%d/%y")) %>%
  ungroup()
#tmp <- d2_usa %>% mutate('Country/Region' = 'United States')
\#d2\_glo \leftarrow rbind(tmp, d2\_glo)
#d2_glo
country_order_desc <- d2_glo %>%
 filter(dated==max(dated)) %>%
 arrange(desc(n_cases_confirmed)) %>%
 select(`Country/Region`) %>%
  c()
d3_glo <- d2_glo %>%
  mutate(`Country/Region` =
           fct_relevel(`Country/Region`,
                     levels = c(country_order_desc)))
## Warning: Outer names are only allowed for unnamed scalar atomic inputs
ggplot(d3_glo, aes(dated, n_cases_confirmed, colour = `Country/Region`)) +
 geom_line() +
  scale_x_date('Recorded dates',
               breaks = function(x) seq.Date(from = min(x),
                                              to = max(x),
                                               by = "1 week")) +
  scale_y_continuous('Number of confirmed cases cumulative (by country)',
                     breaks = function (x) round(seq.int(from = min(x),
                                to = max(x),
                                length.out = 10))) +
  theme minimal() +
  theme(legend.position = "bottom",
        legend.title = element_blank()) +
  guides(col = guide_legend(nrow = 20))
```



d3_glo

```
## # A tibble: 13,505 x 3
##
      `Country/Region` dated
                                  n_cases_confirmed
##
      <fct>
                       <date>
                                               <dbl>
   1 Afghanistan
                       2020-01-29
                                                   0
##
   2 Afghanistan
                       2020-01-30
                                                   0
##
##
  3 Afghanistan
                       2020-01-31
                                                   0
##
  4 Afghanistan
                       2020-02-01
                                                   0
##
  5 Afghanistan
                       2020-02-10
                                                   0
                       2020-02-11
                                                   0
##
  6 Afghanistan
##
   7 Afghanistan
                       2020-02-12
                                                   0
##
   8 Afghanistan
                       2020-02-13
                                                   0
   9 Afghanistan
                       2020-02-14
                                                   0
##
## 10 Afghanistan
                       2020-02-15
## # ... with 13,495 more rows
d3_glo %>%
  group_by(`Country/Region`) %>%
  arrange(dated) %>%
  mutate(n_bydateirmed = ifelse(dated != min(d3_glo$dated),
                                        n_cases_confirmed -
```

d3_glo[which(d3_glo\$dated == dated &

```
d3_glo$`Country/Region` == `Country/Region`),
                                                 "n_cases_confirmed"], 0))
## # A tibble: 13,505 x 4
## # Groups:
               Country/Region [185]
##
      `Country/Region`
                          dated
                                     n_cases_confirmed n_bydateirmed
##
      <fct>
                          <date>
                                                 <dbl> <list>
## 1 Afghanistan
                                                     0 <dbl [1]>
                          2020-01-29
                                                     0 <dbl [1]>
## 2 Albania
                          2020-01-29
## 3 Algeria
                                                     0 <dbl [1]>
                          2020-01-29
## 4 Andorra
                          2020-01-29
                                                     0 <dbl [1]>
## 5 Angola
                          2020-01-29
                                                     0 <dbl [1]>
## 6 Antigua and Barbuda 2020-01-29
                                                     0 <dbl [1]>
## 7 Argentina
                                                     0 <dbl [1]>
                          2020-01-29
## 8 Armenia
                          2020-01-29
                                                     0 <dbl [1]>
## 9 Australia
                          2020-01-29
                                                     6 <dbl [1]>
## 10 Austria
                          2020-01-29
                                                     0 <dbl [1]>
## # ... with 13,495 more rows
d4_glo <- d3_glo
d4_glo <- d4_glo %>%
 mutate(`Country/Region` = as.character(`Country/Region`)) %>%
  as.data.frame()
cl <- makeCluster(parallel::detectCores())</pre>
registerDoParallel(cl)
tmp = foreach (i = 1:nrow(d4_glo), .combine = 'c', .inorder=T) %dopar% {
  cty = as.character(d4 glo[i, 'Country/Region'])
  dt = d4_glo [i, 'dated']
  dts = d4_glo[order(as.Date(d4_glo[which(d4_glos Country/Region == cty), 'dated'])), 'dated']
  dt_pos = which(dts == dt)
  if (dt_pos > 1){
   prev_dt = dts[dt_pos-1]
   d4_glo[i,'n_cases_confirmed'] - d4_glo[which(d4_glo[,'Country/Region'] == cty &
                                                    d4_glo[,'dated'] == prev_dt),'n_cases_confirmed']
 }else{
    0
  }
}
stopCluster(cl)
d4_glo$n_bydate = unlist(tmp)
d4_glo <- d4_glo %>%
  mutate(`Country/Region` = as.factor(`Country/Region`))
ggplot(d4_glo, aes(dated, n_bydate, colour = `Country/Region`)) +
 geom_line() +
  scale_x_date('Recorded dates',
               breaks = function(x) seq.Date(from = min(x),
                                              to = max(x),
                                              by = "1 week")) +
```

```
scale_y_continuous('Number of confirmed cases per date (by country)',
                                                                 breaks = function (x) round(seq.int(from = min(x),
                                                                                                  to = max(x),
                                                                                                  length.out = 10))) +
      theme_minimal() +
      theme(legend.position = "bottom",
                         legend.title = element_blank()) +
      guides(col = guide_legend(nrow = 20))
  cases
  of confirmed
        2020 - 01 - 25 \quad 2020 - 02 - 01 \quad 2020 - 02 - 08 \quad 2020 - 02 - 15 \quad 2020 - 02 - 22 \quad 2020 - 02 - 29 \quad 2020 - 03 - 07 \quad 2020 - 03 - 14 \quad 2020 - 03 - 21 \quad 2020 - 03 - 28 \quad 2020 - 04 - 04 \quad 2020 - 04 - 11 \quad 2020 - 03 - 2020 - 03 - 2020 - 03 - 2020 - 03 - 2020 - 03 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 2020 - 20
                                                                                                                                   Recorded dates
                              — Costa Rica
                                                                        — Finland

    Saint Kitts and Nevis

                                                                                                          Iran
                                                                                                                                          Lithuania

    Netherlands

a and Herzegovina — Cote d'Ivoire
                                                                           France
                                                                                                                                              Luxembourg

    New Zealand

                                                                                                                                                                                                                  — Saint Lucia
                                                                                                              Iraq
annN
                               — Croatia
                                                                           Gabon

    Ireland

                                                                                                                                                                                                                        Saint Vincent and the Grenadines
                                                                                                                                                Madagascar
                                                                                                                                                                             - Nicaragua
                                 Cuba
                                                                            - Gambia
                                                                                                               Israel
                                                                                                                                                                                                                        San Marino
                                                                                                                                                Malawi
                                                                                                                                                                             - Niger
                                                                                                                                                Malaysia
                               — Cyprus

    Georgia

    Nigeria

    Sao Tome and Principe

                                                                                                             Italy
ia
                               — Czechia

    Germany

    Jamaica

                                                                                                                                                 Maldives

    North Macedonia

                                                                                                                                                                                                                 — Saudi Arabia
a Faso
                                 Denmark
                                                                           Ghana
                                                                                                             Japan
                                                                                                                                                                           Norway
                                                                                                                                                                                                                  Senegal

    Diamond Princess

                                                                            - Greece
                                                                                                                                                                             - Oman
                                                                                                                                                                                                                       Serbia

    Jordan

                                                                                                                                                Malta
                                 Djibouti
                                                                         — Grenada
                                                                                                                                                                        — Pakistan
                                                                                                                                                                                                                  Seychelles
di
                                                                                                           Kazakhstan
                                                                                                                                        — Mauritania

    Dominica

    Guatemala

                                                                                                              Kenya
                                                                                                                                                Mauritius
                                                                                                                                                                         Panama
                                                                                                                                                                                                                  Sierra Leone
Verde
odia
                                   - Dominican Republic - Guinea

    Korea, South

                                                                                                                                              Mexico

    Papua New Guinea — Singapore

                               — Ecuador
                                                                           - Guinea-Bissau - Kosovo
                                                                                                                                                                            Paraguay

    Slovakia

                                                                                                                                               Moldova
roon
                                Egypt
                                                                        Guyana
                                                                                                                                                                                                                 — Slovenia
la
                                                                                                             Kuwait
                                                                                                                                                Monaco
                                                                                                                                                                         — Peru
ıl African Republic - El Salvador
                                                                         Haiti
                                                                                                           — Kyrgyzstan
                                                                                                                                                 Mongolia
                                                                                                                                                                         Philippines
                                                                                                                                                                                                                  — Somalia
                                Equatorial Guinea — Holy See
                                                                                                           Laos
                                                                                                                                                                        Poland
                                                                                                                                                                                                                  — South Africa
                                — Eritrea
                                                                         Honduras
                                                                                                            Latvia
                                                                                                                                                                           Portugal
                                                                                                                                                                                                                  South Sudan
                                                                                                                                                Morocco
                               — Estonia
                                                                        — Hungary
                                                                                                          Lebanon
                                                                                                                                                                                                                 — Spain
                                                                                                                                                Mozambique
                                                                                                                                                                      — Qatar
                               — Eswatini

    Iceland

    Liberia

 MS Zaandam

                                                                                                                                                                                Romania
                                                                                                                                                                                                                 — Sri Lanka
(Brazzaville)
                                 Ethiopia
                                                                        — India
                                                                                                          Libya

    Namibia

                                                                                                                                                                            Russia
                                                                                                                                                                                                                  Sudan
(Kinshasa)
                               — Fiji
                                                                             Indonesia

    Liechtenstein

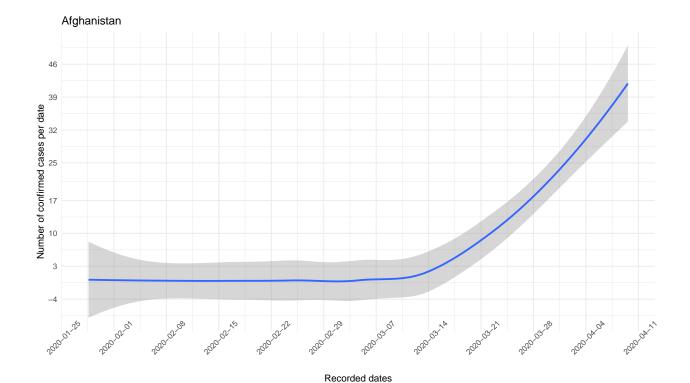
                                                                                                                                              - Nepal
                                                                                                                                                                                Rwanda
                                                                                                                                                                                                                   Suriname
```

adding smoother

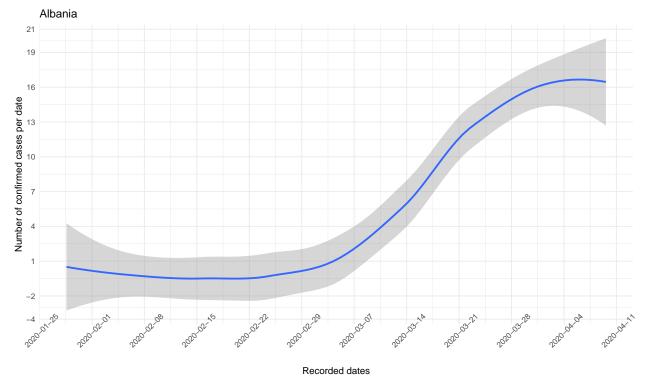
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



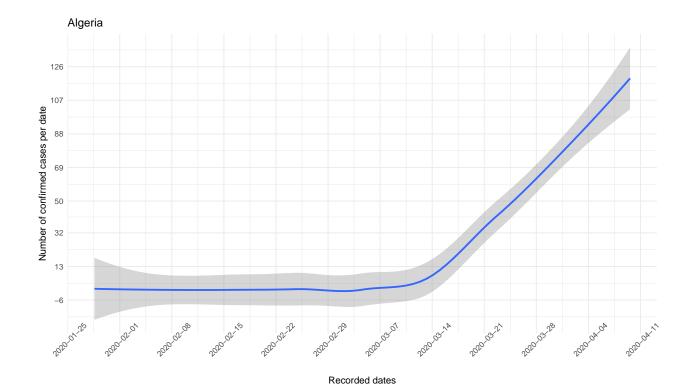
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



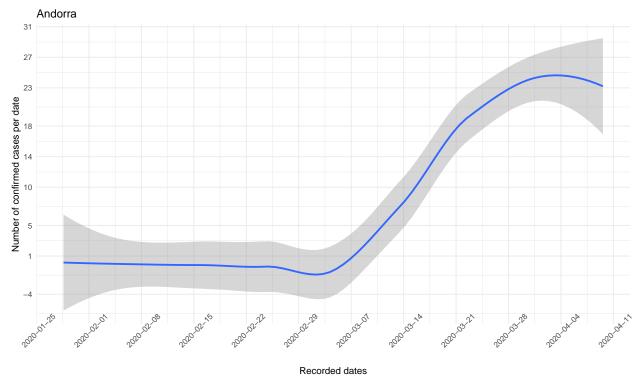
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



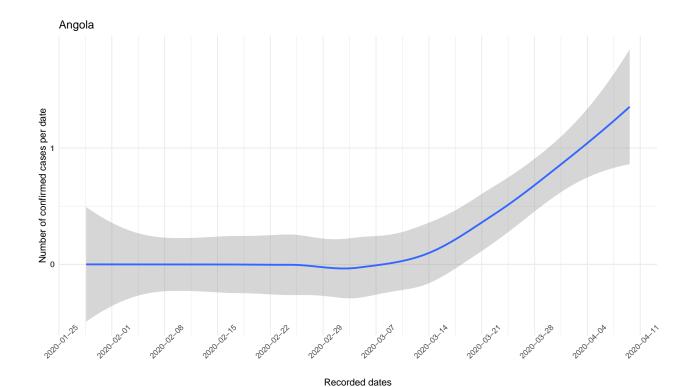
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



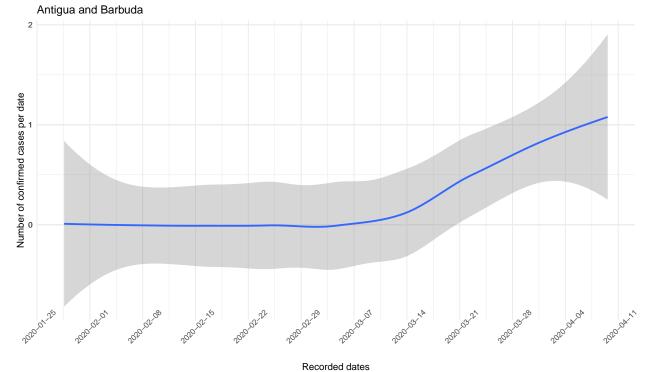
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



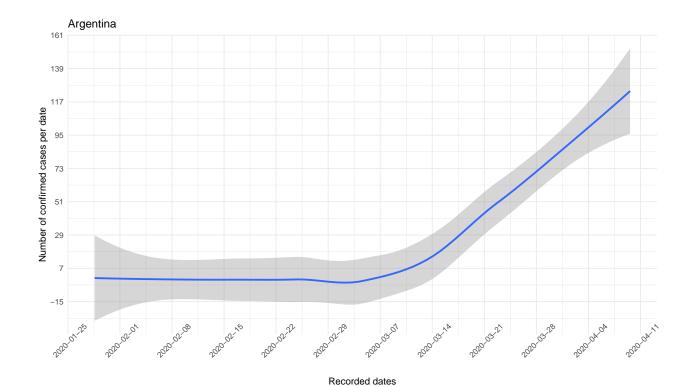
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



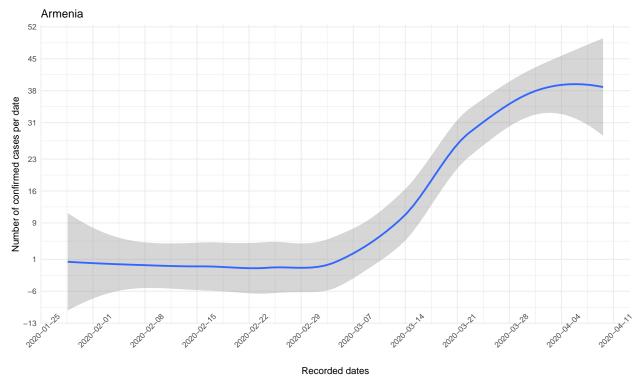
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



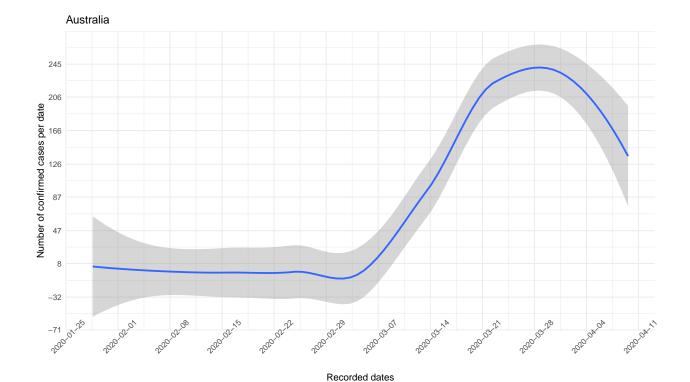
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



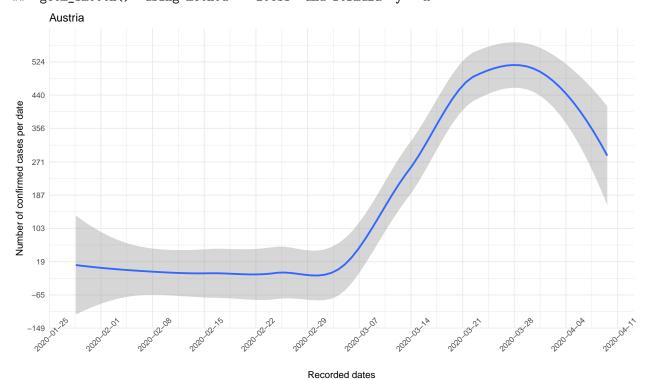
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



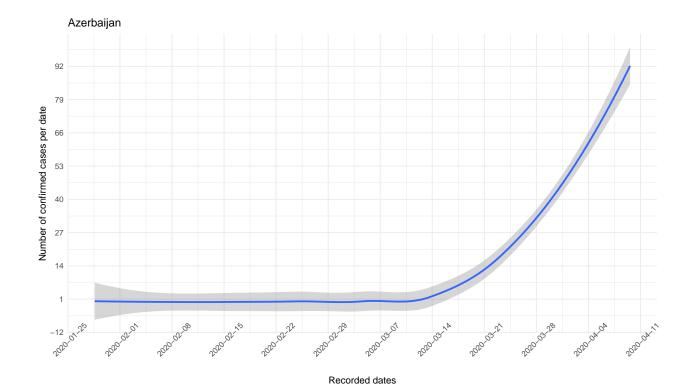
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



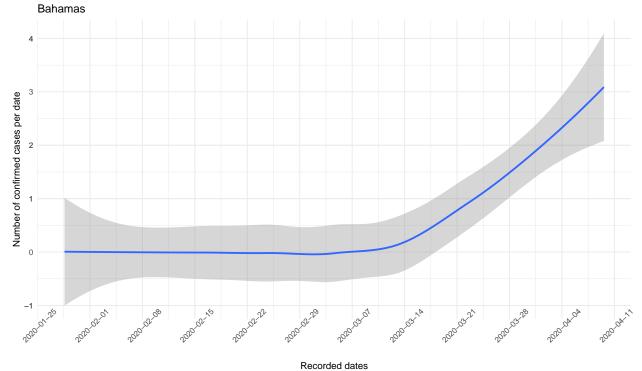
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



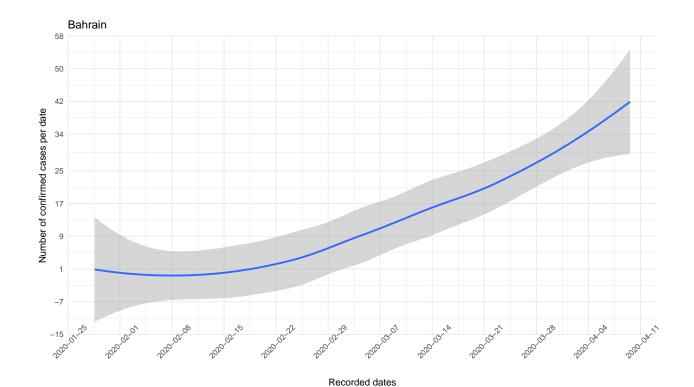
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



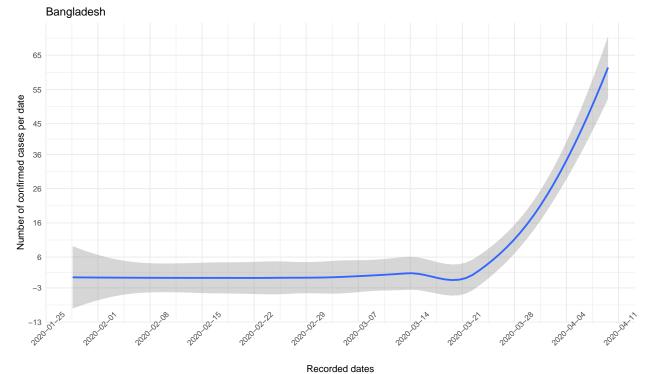
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



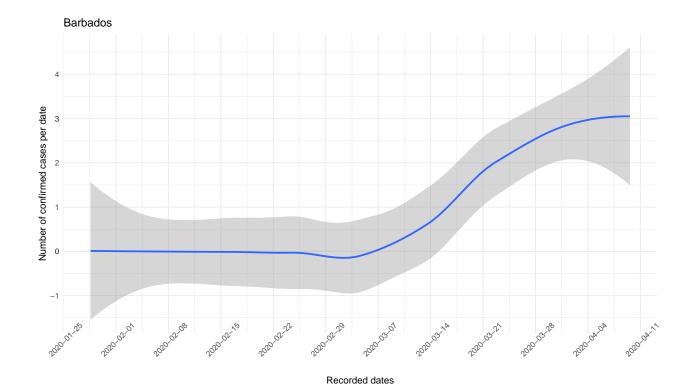
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



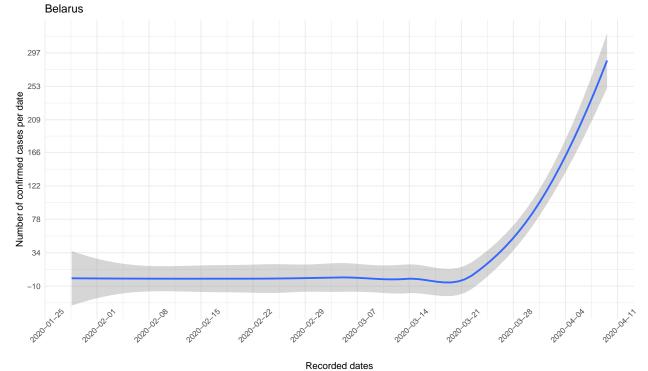
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



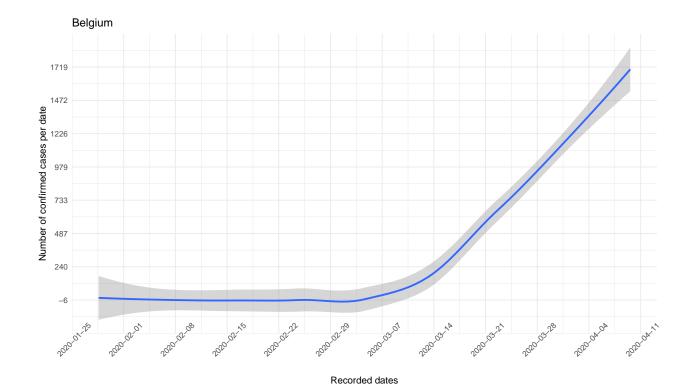
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



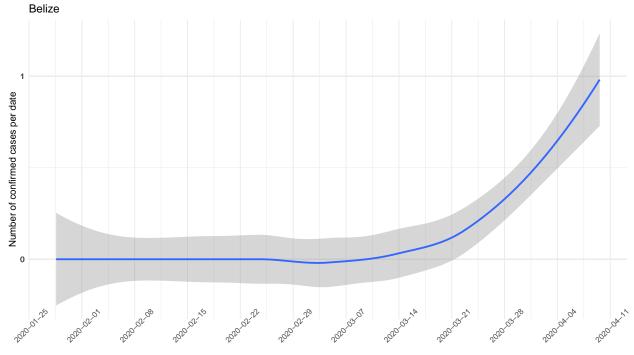
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

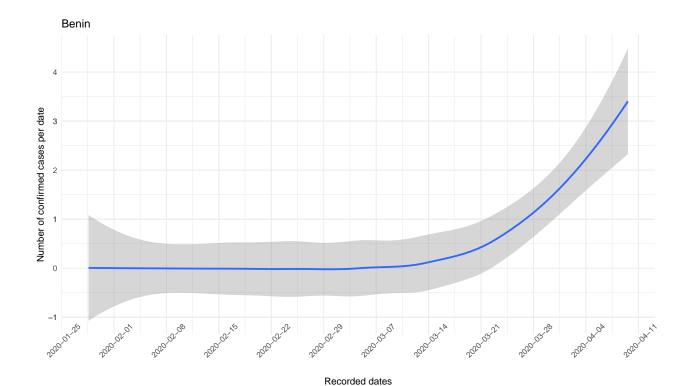


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

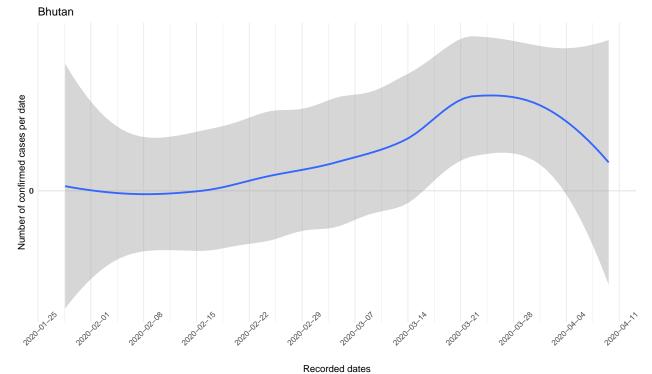


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

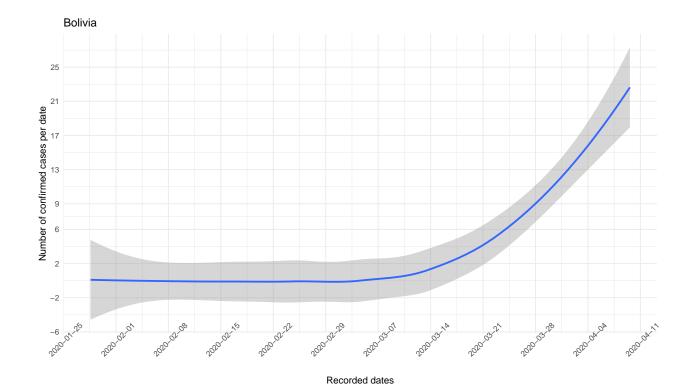
Recorded dates



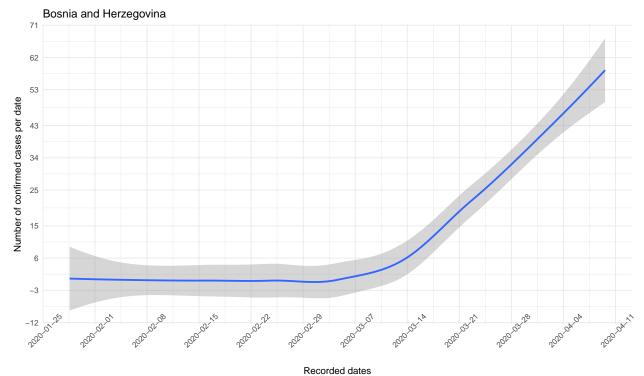
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



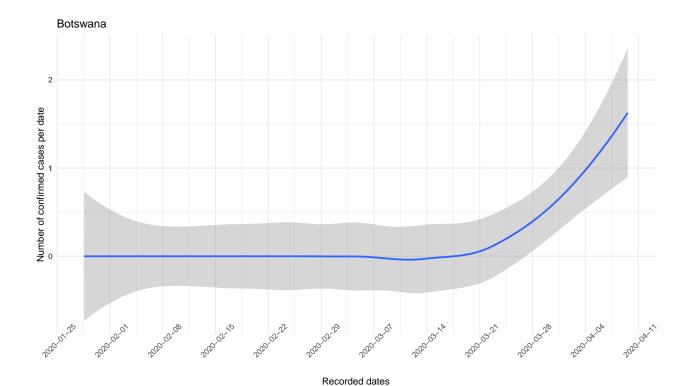
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



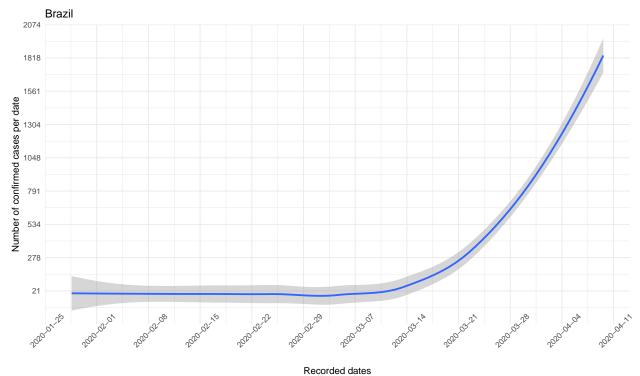
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



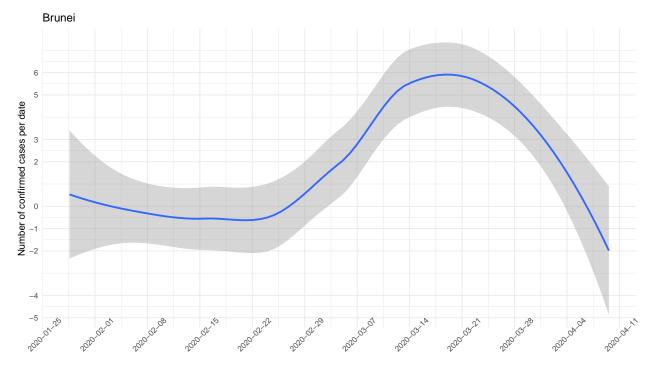
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

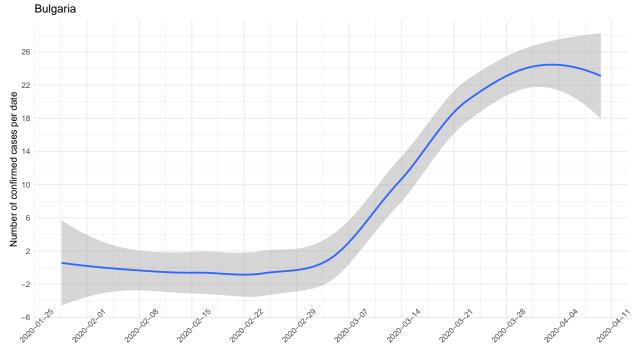


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



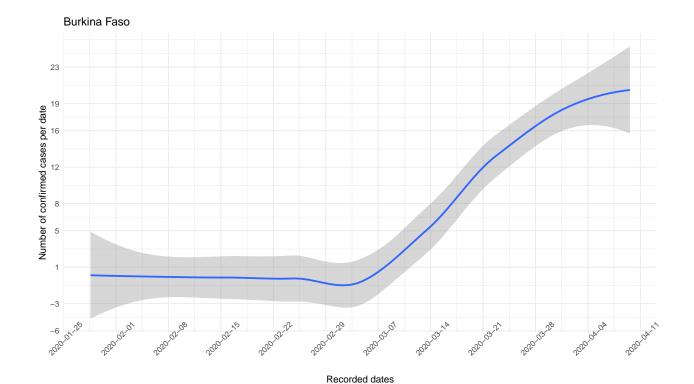
Recorded dates

`geom_smooth()` using method = 'loess' and formula 'y ~ x'

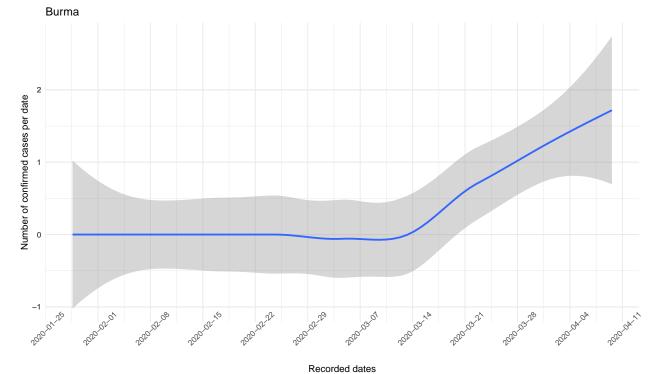


Recorded dates

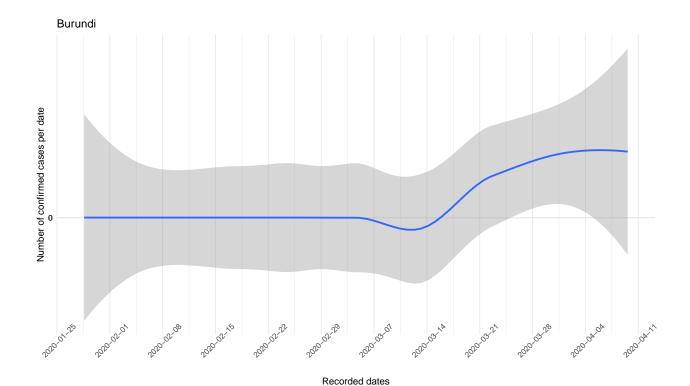
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



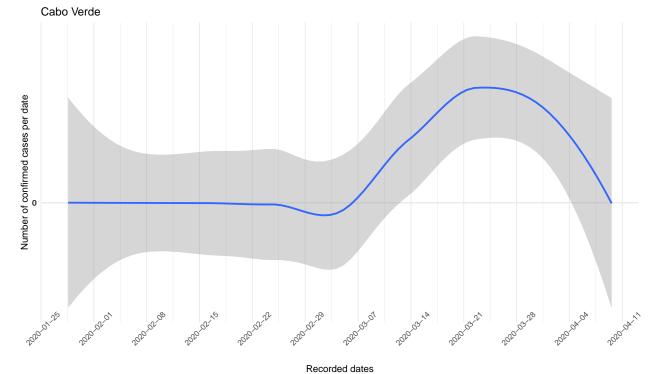
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



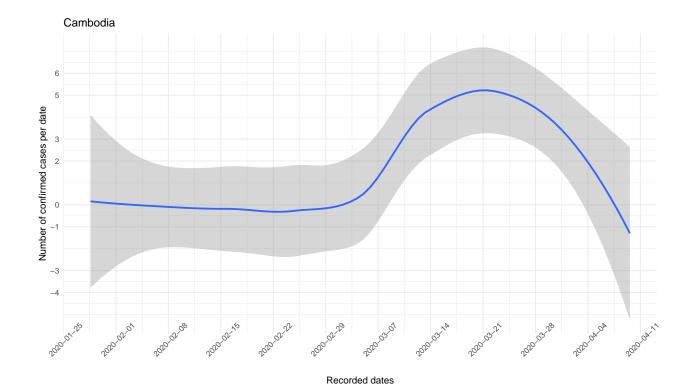
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



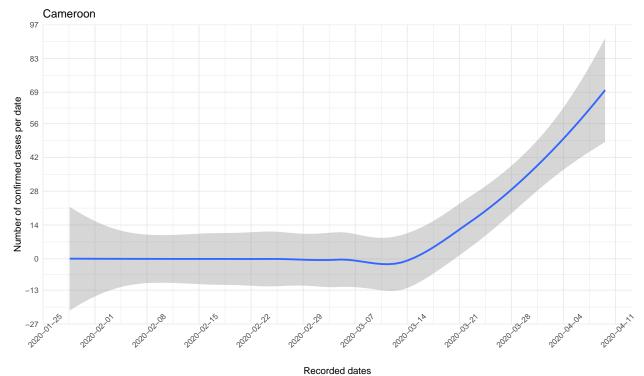
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



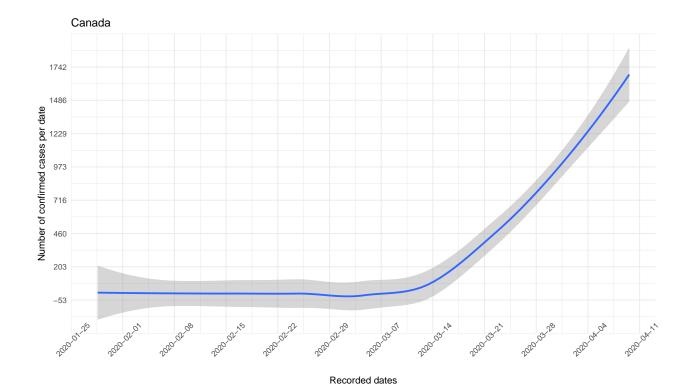
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



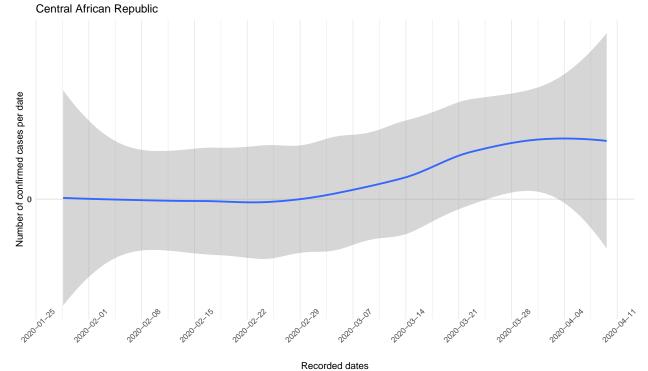
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



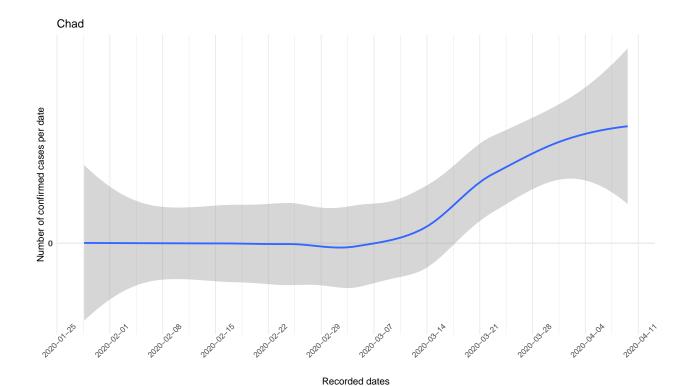
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



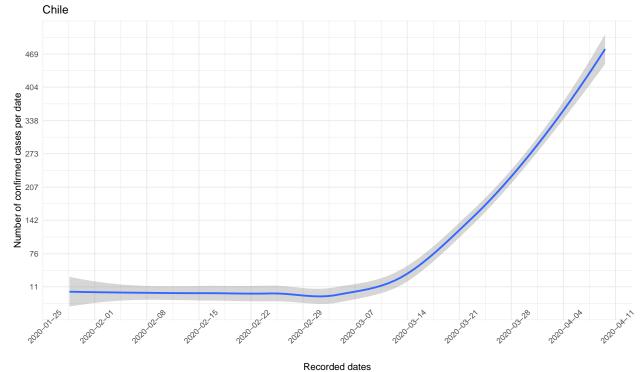
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



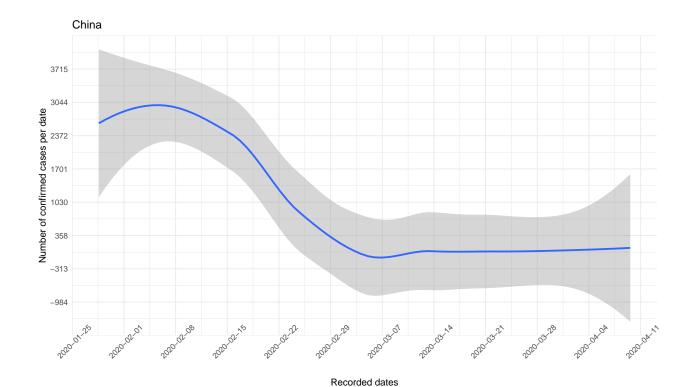
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



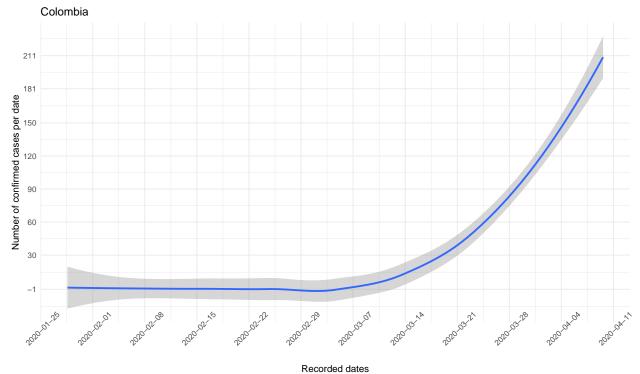
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



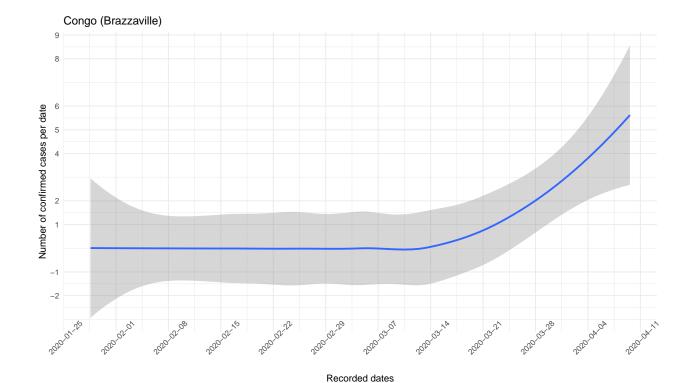
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



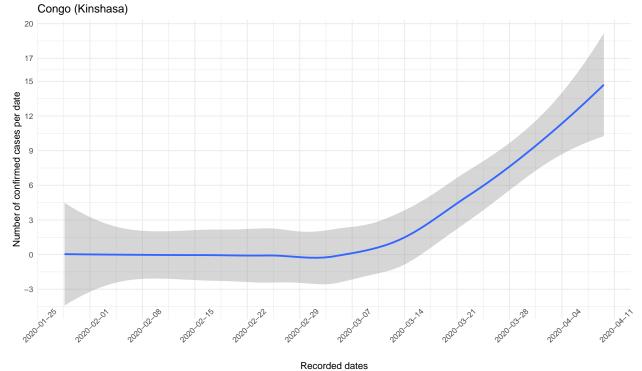
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



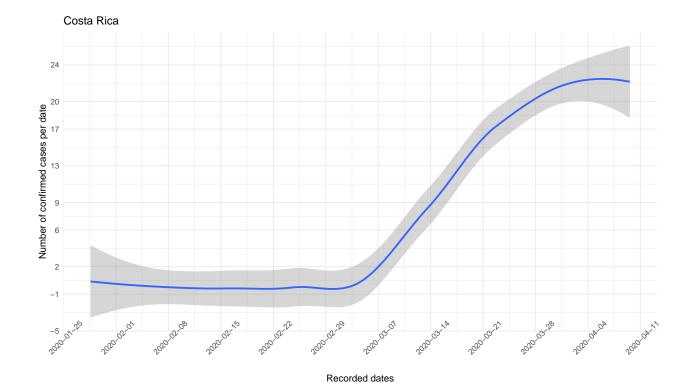
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



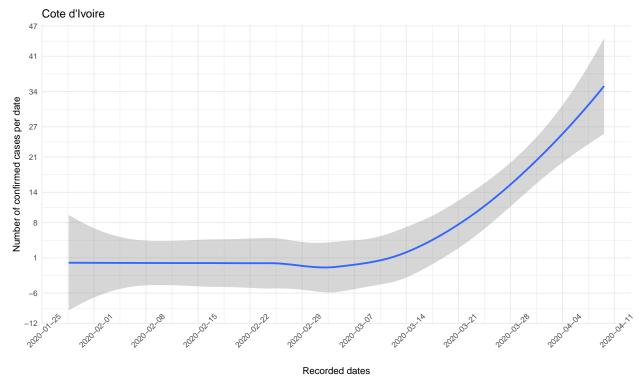
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



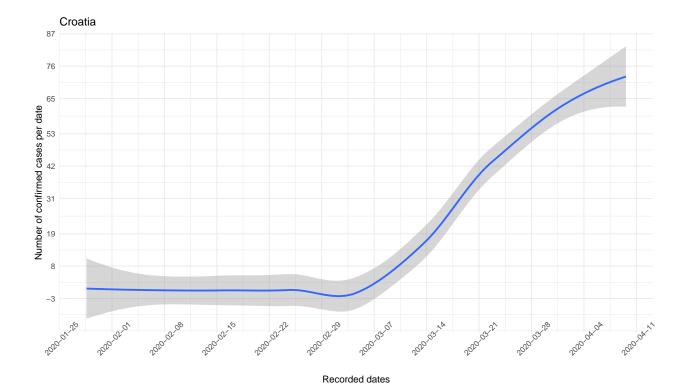
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



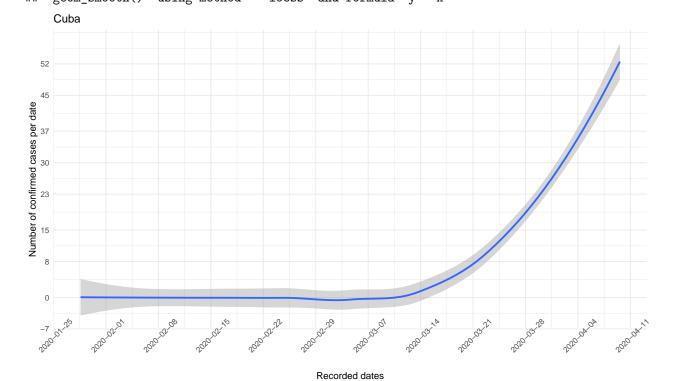
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



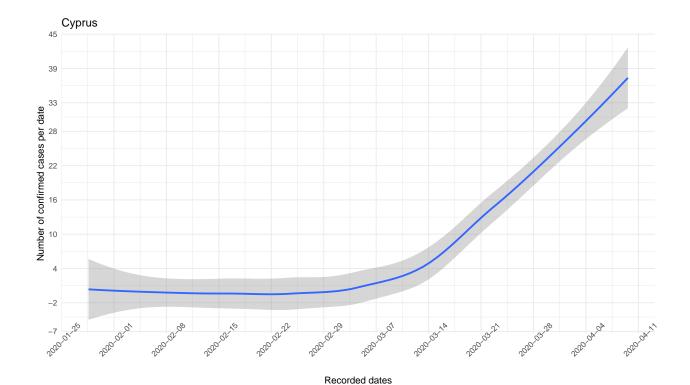
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



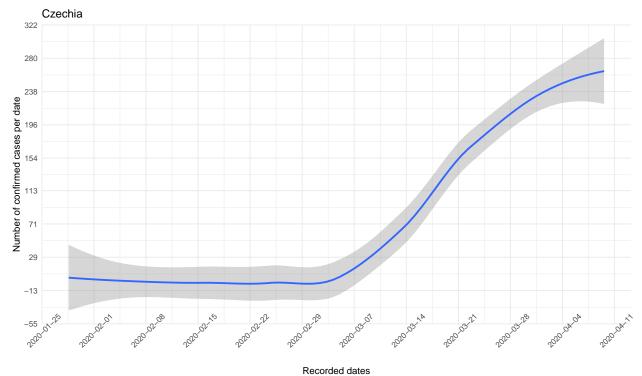
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



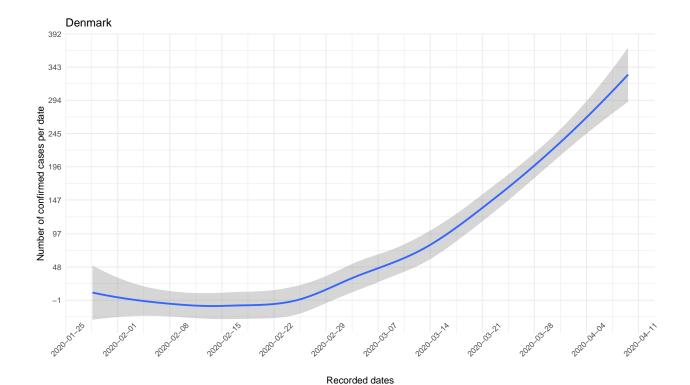
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



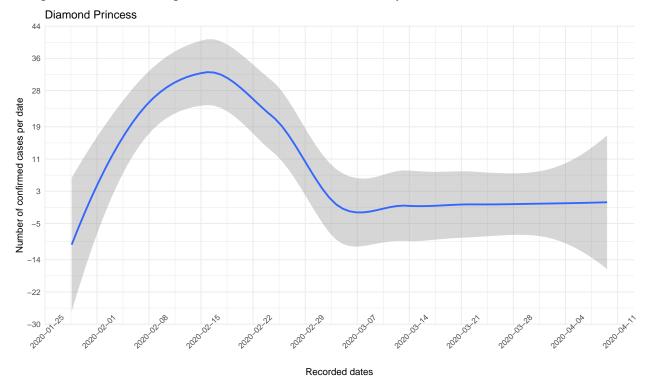
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



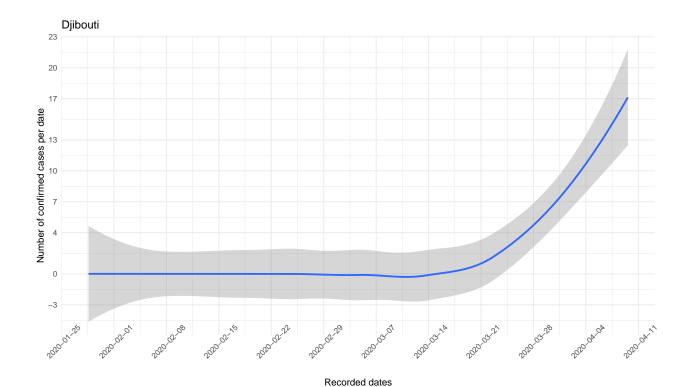
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



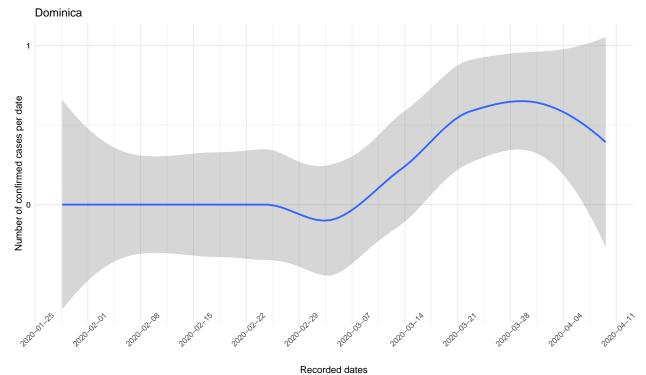
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



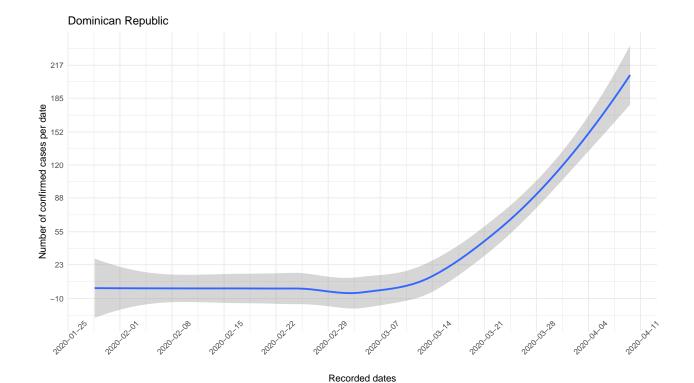
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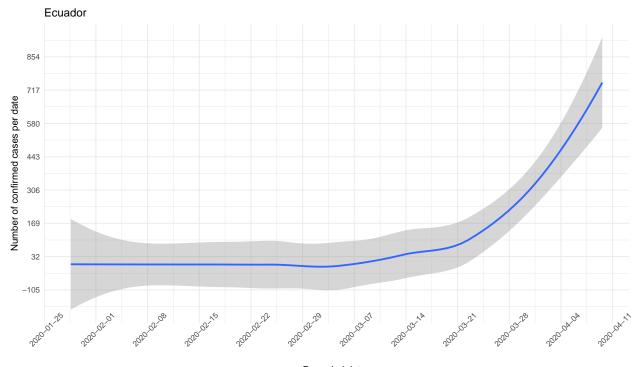
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



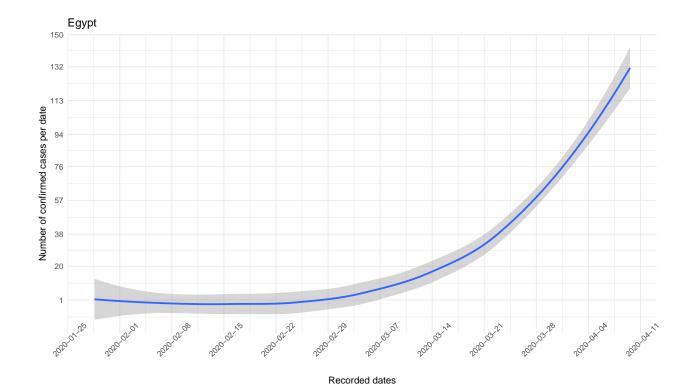
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



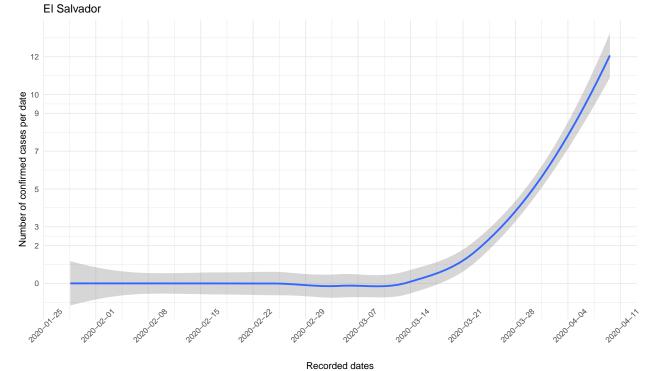
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



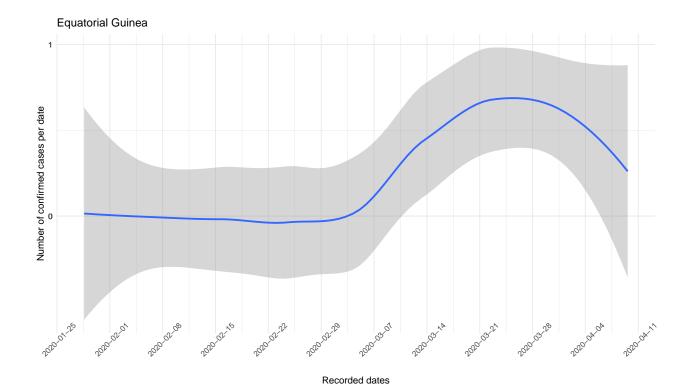
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



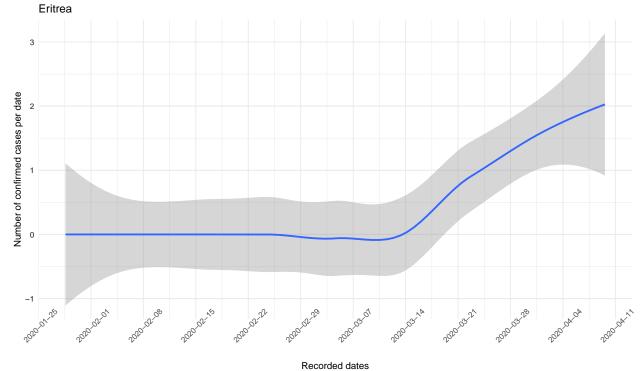
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



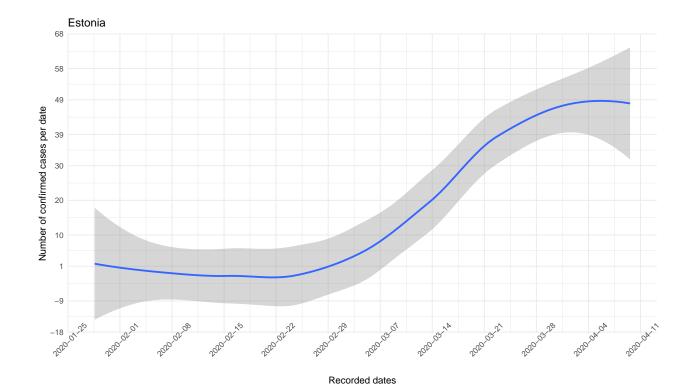
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



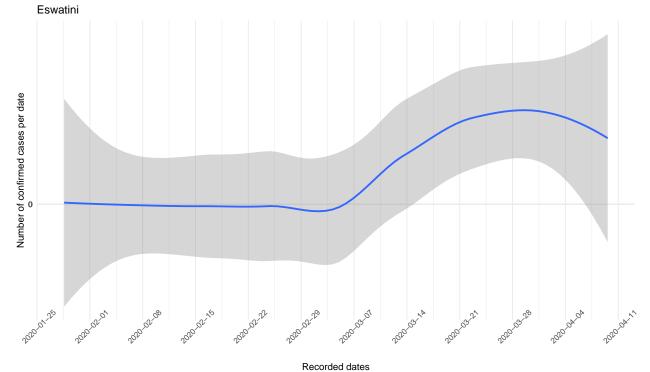
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



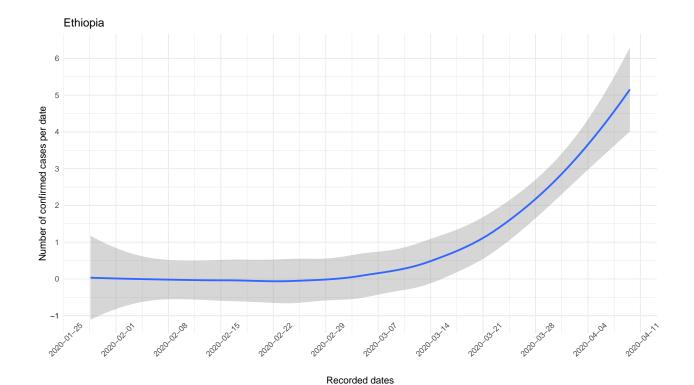
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



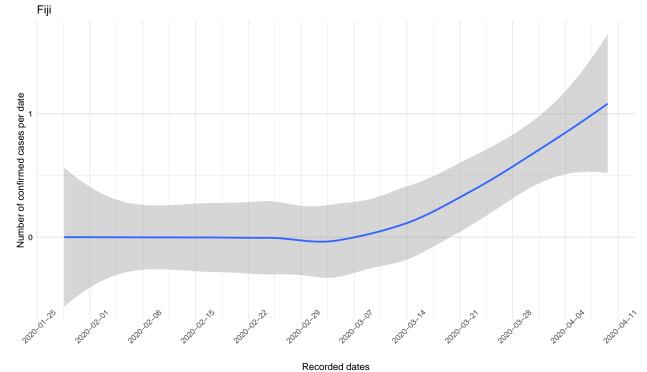
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



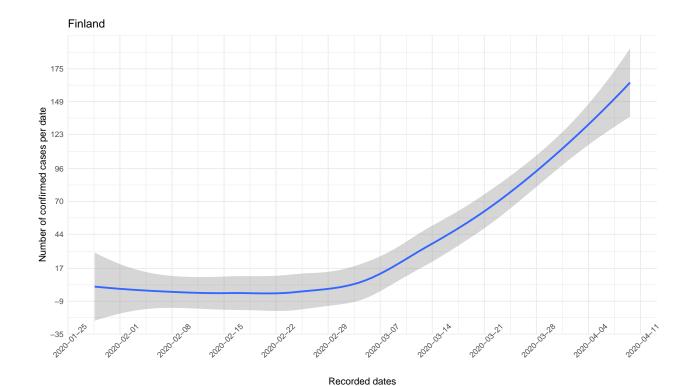
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



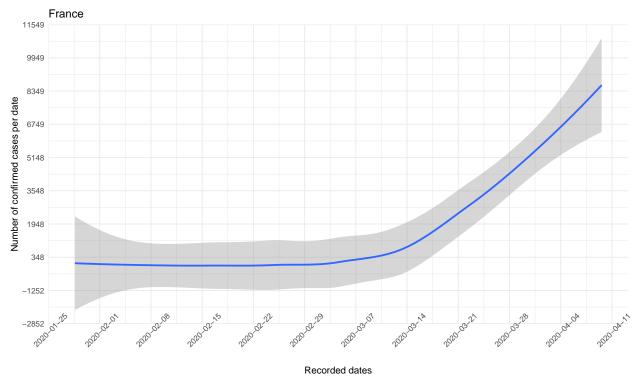
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



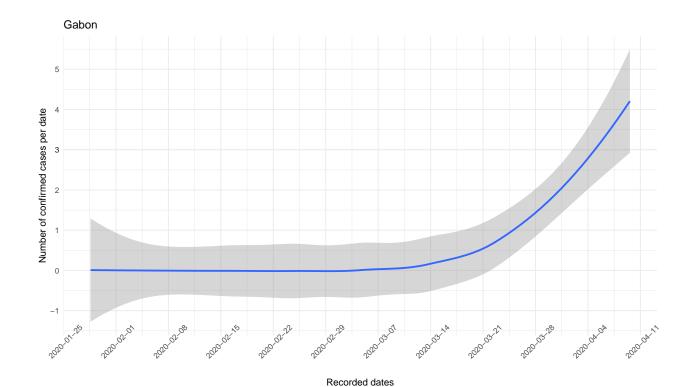
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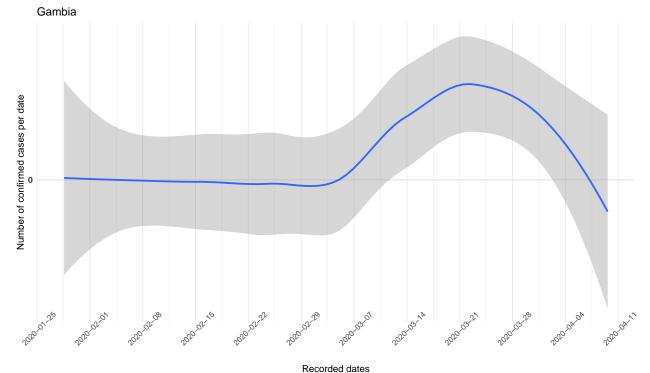
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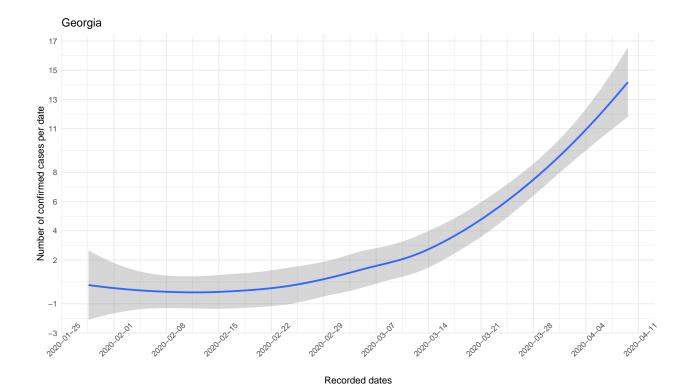
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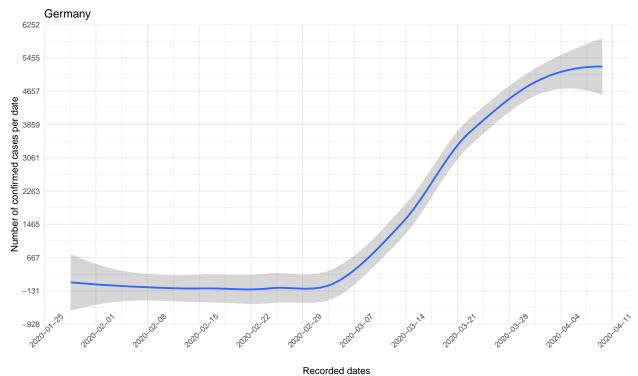
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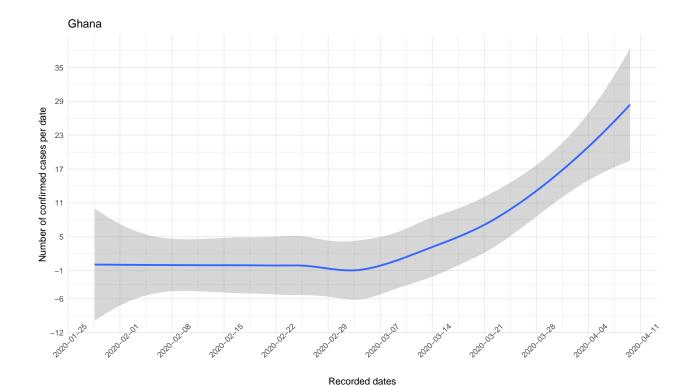
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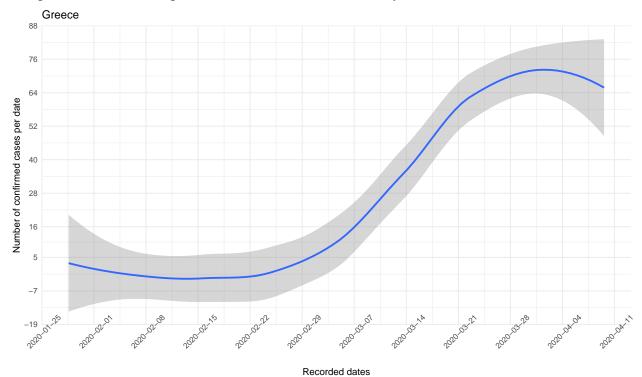
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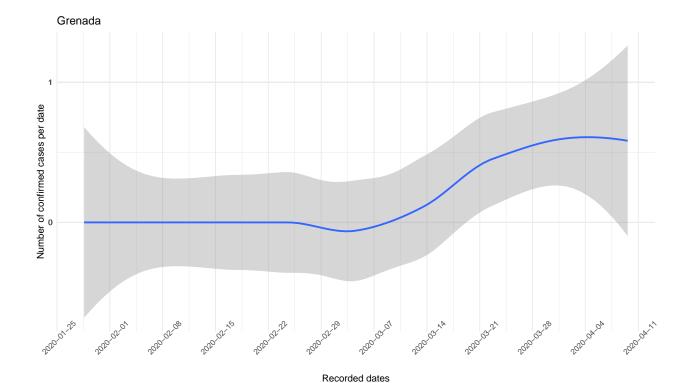
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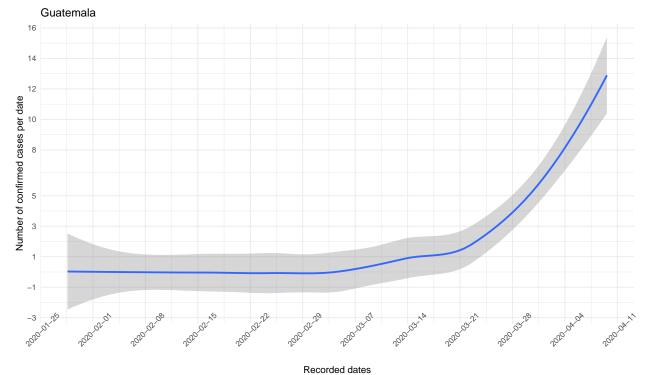
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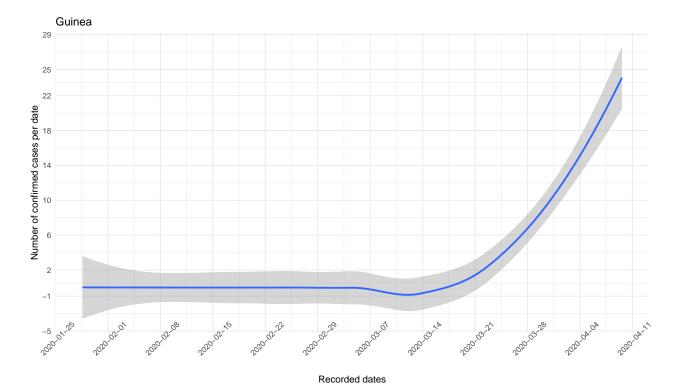
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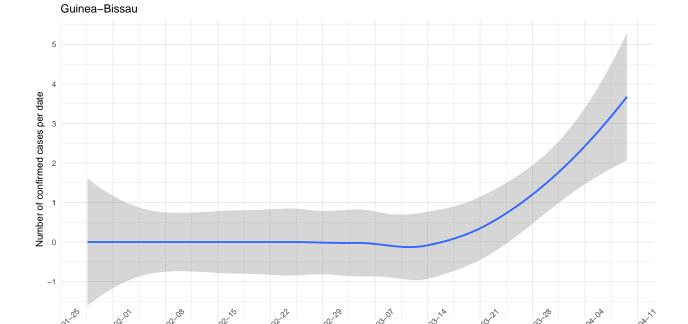
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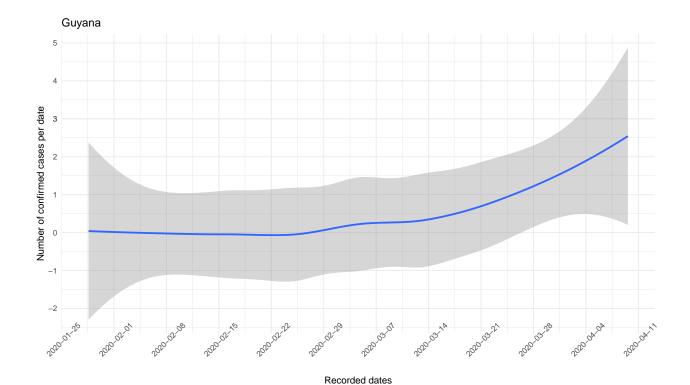
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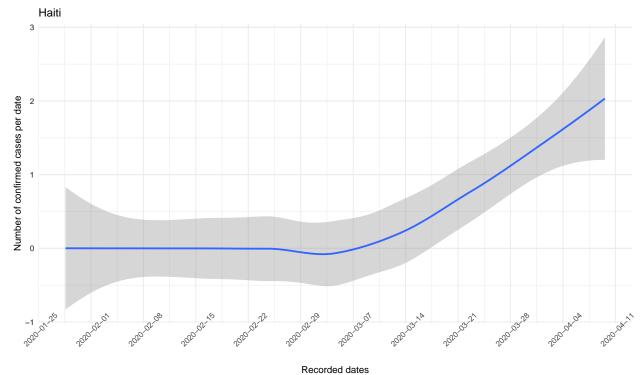
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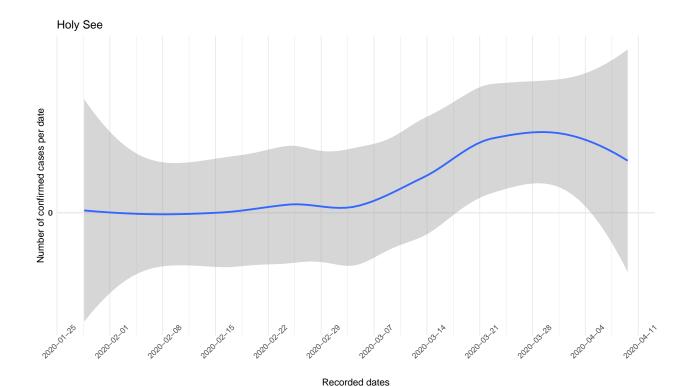
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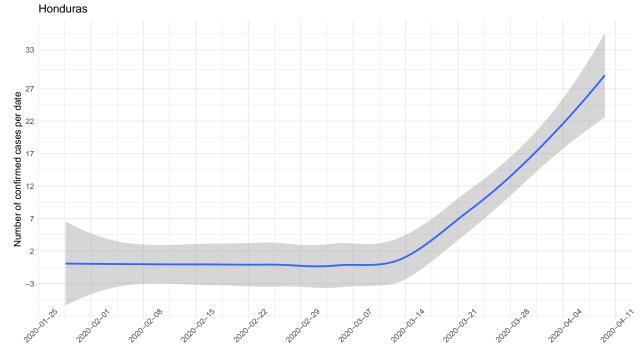
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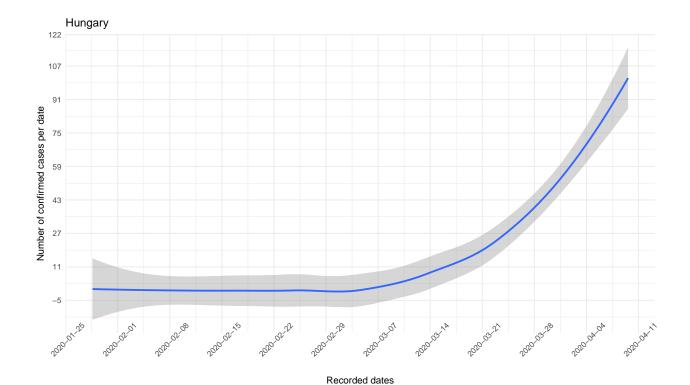
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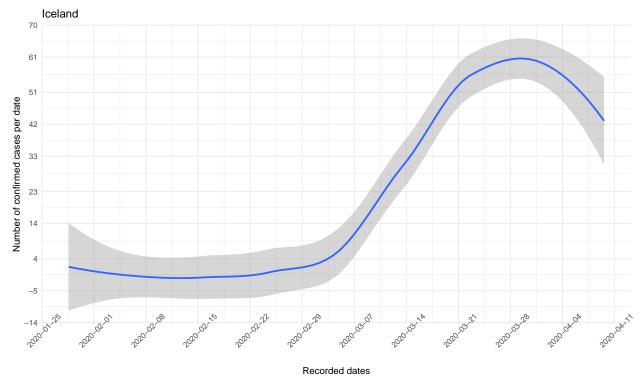
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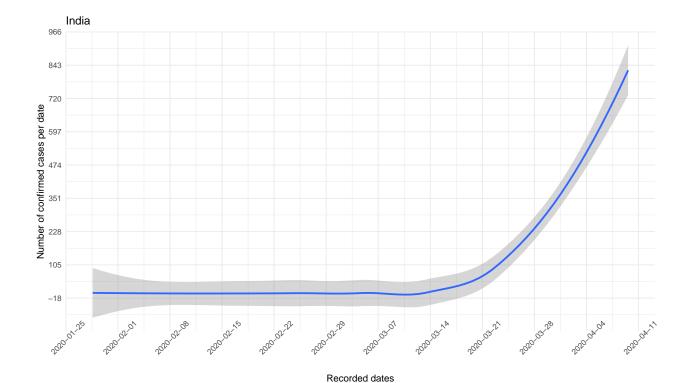
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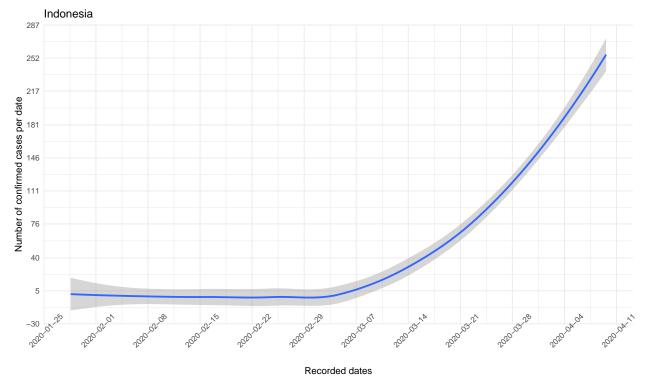
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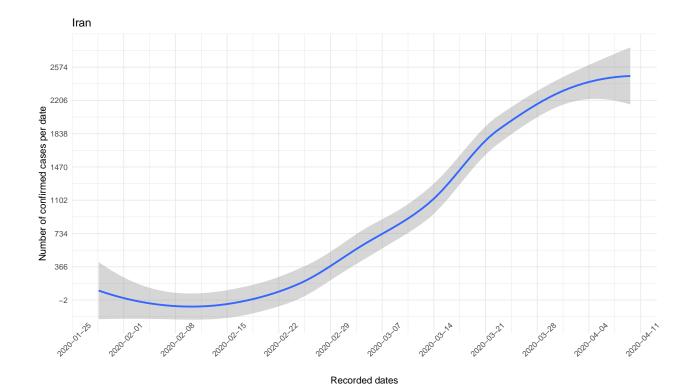
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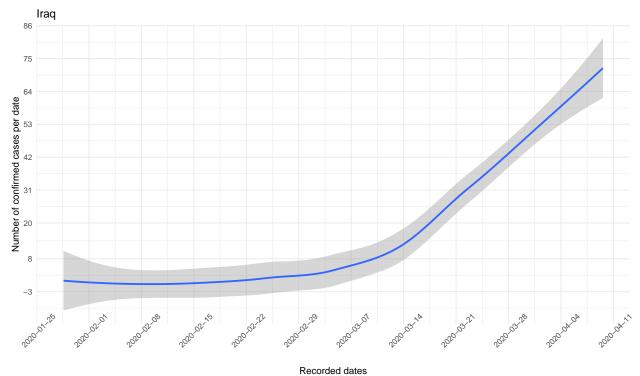
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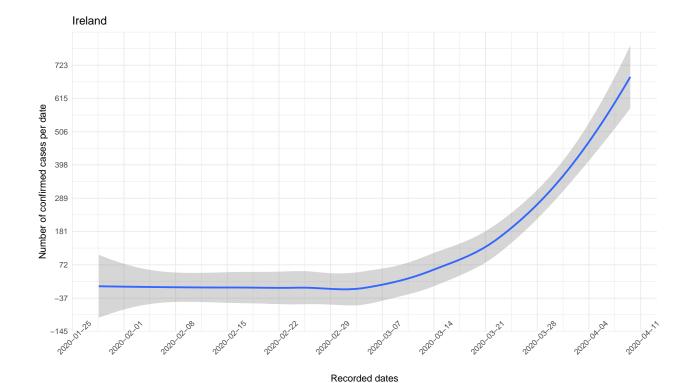
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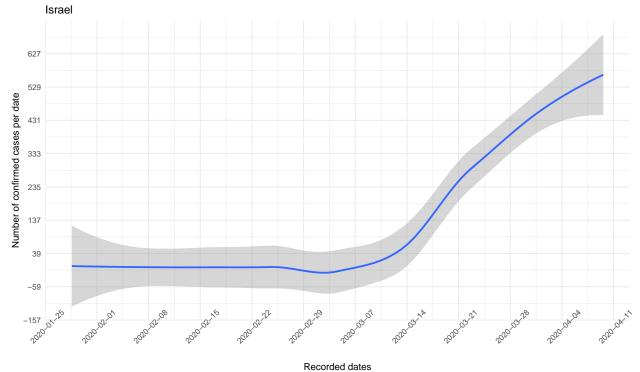
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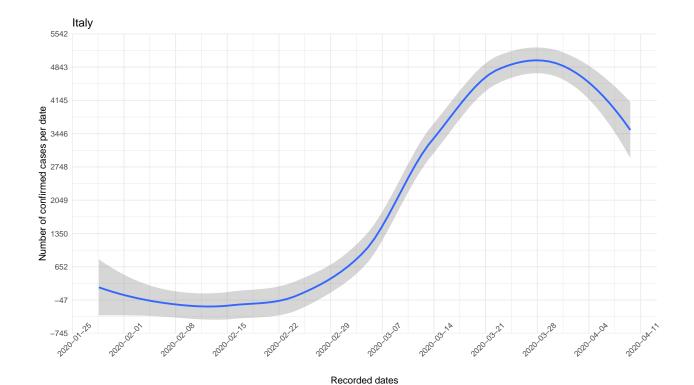
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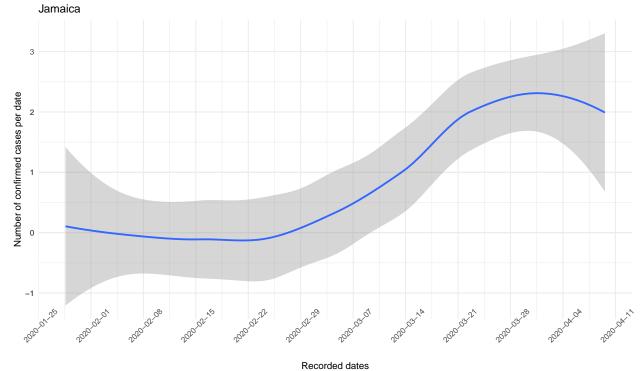
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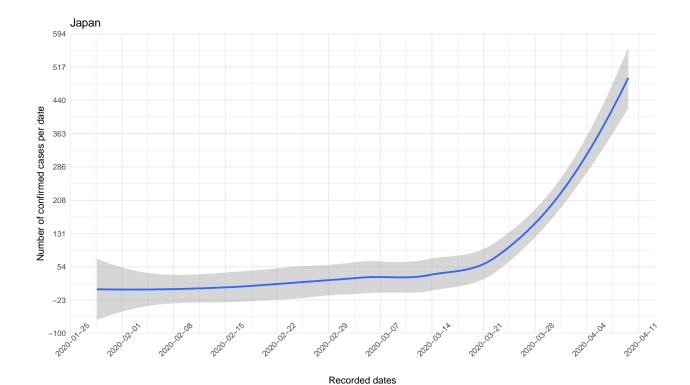
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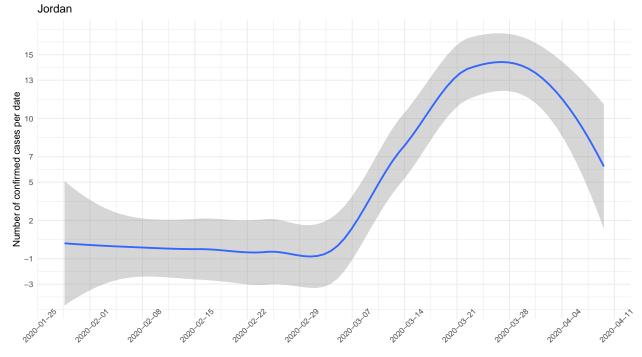
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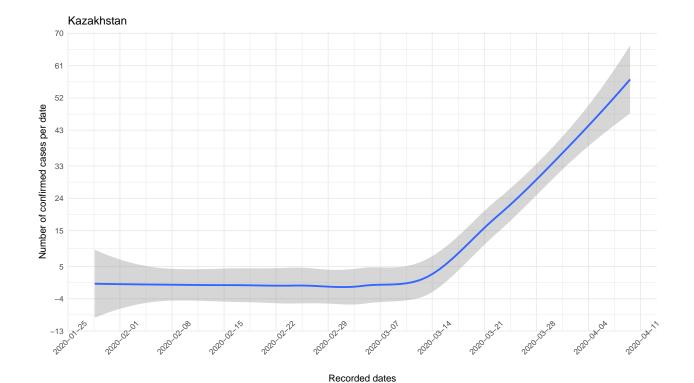
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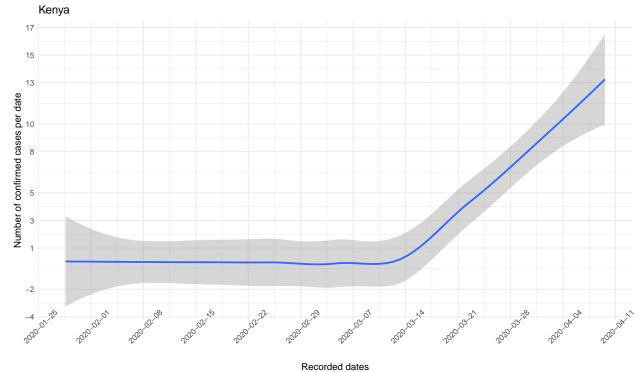
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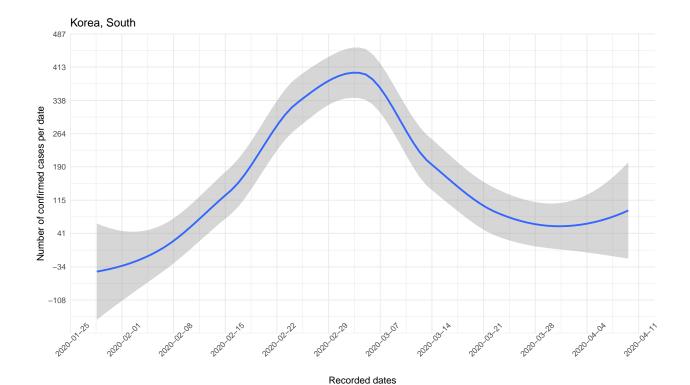
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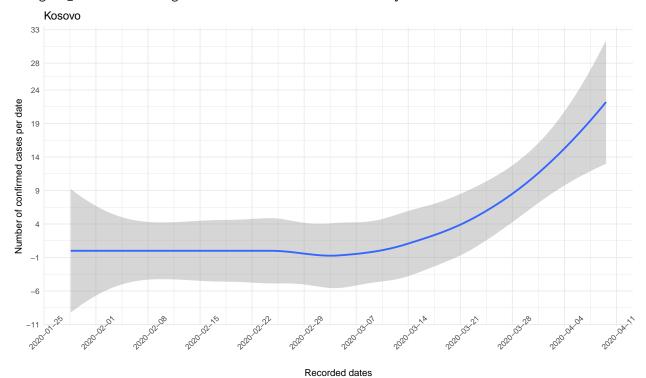
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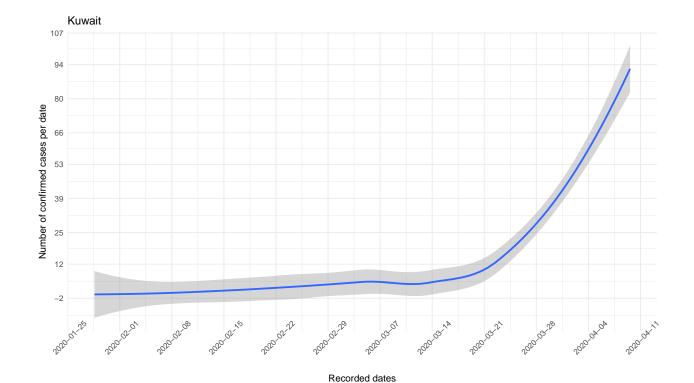
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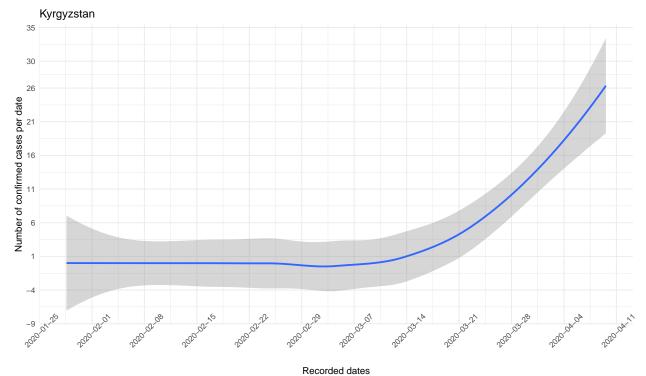
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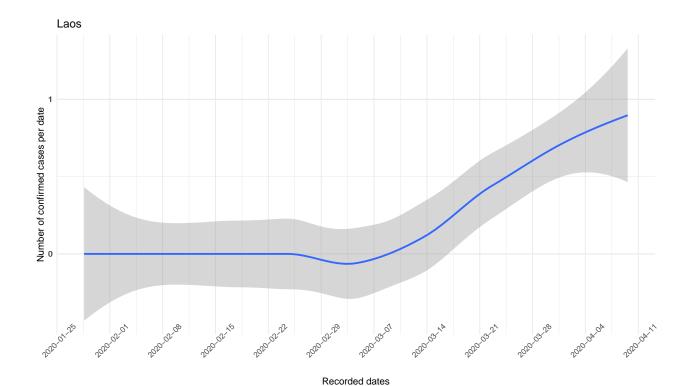
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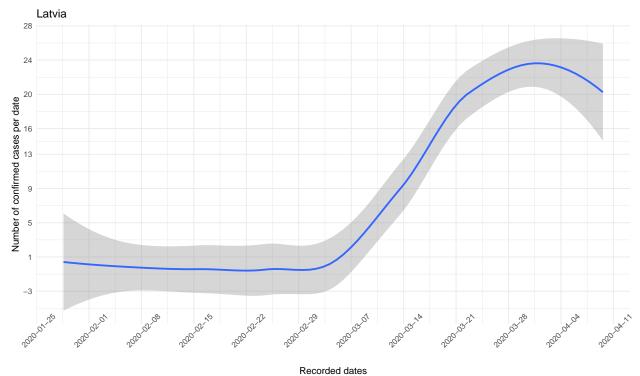
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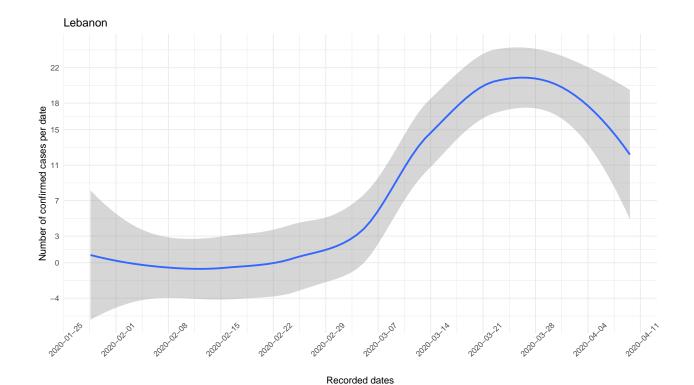
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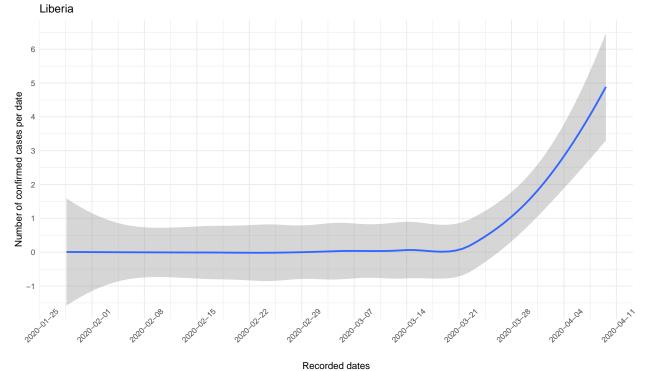
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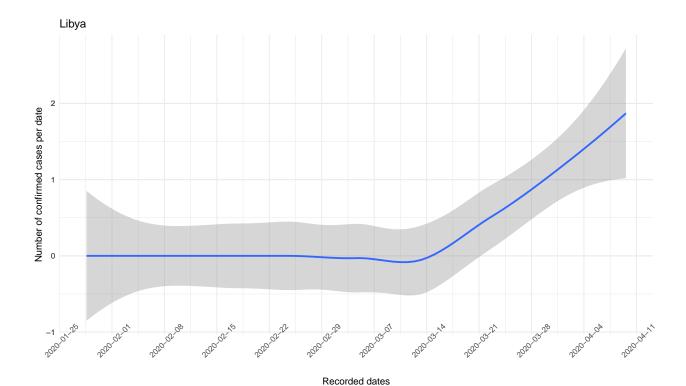
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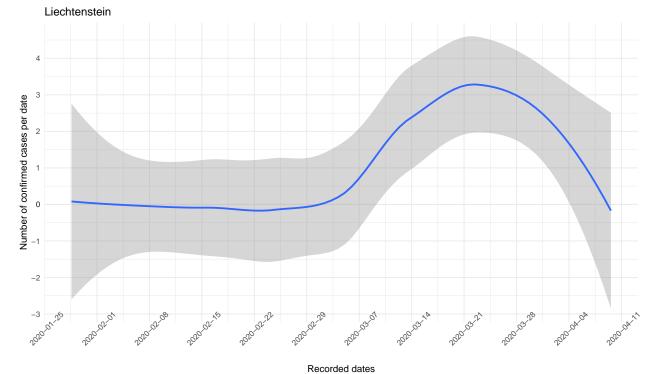
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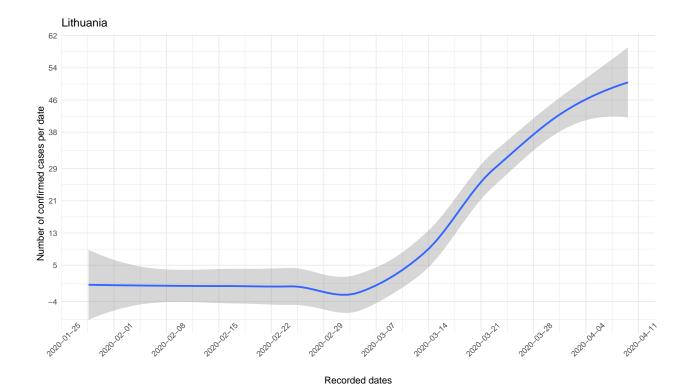
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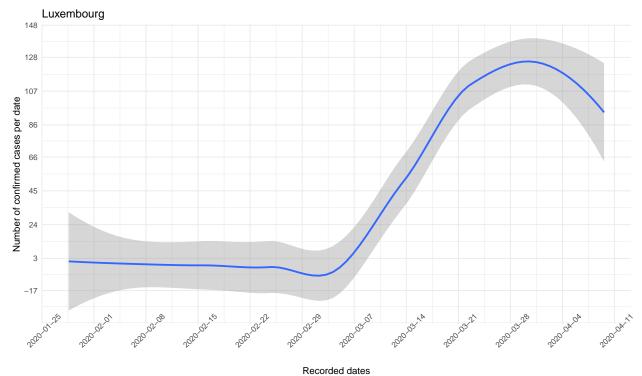
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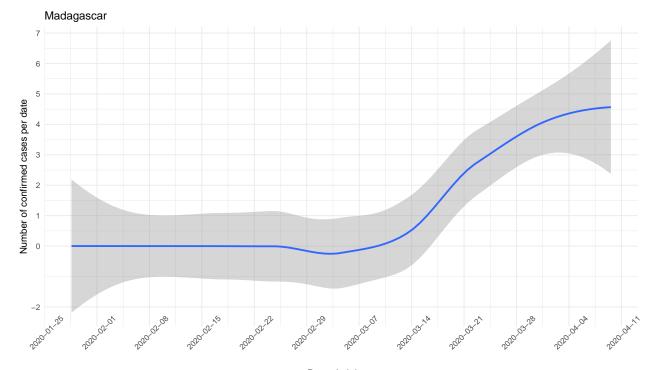
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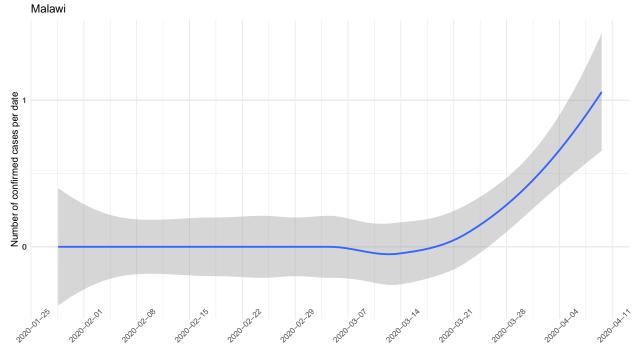
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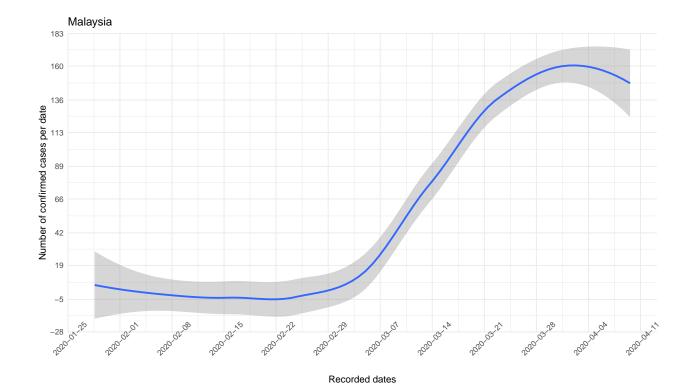
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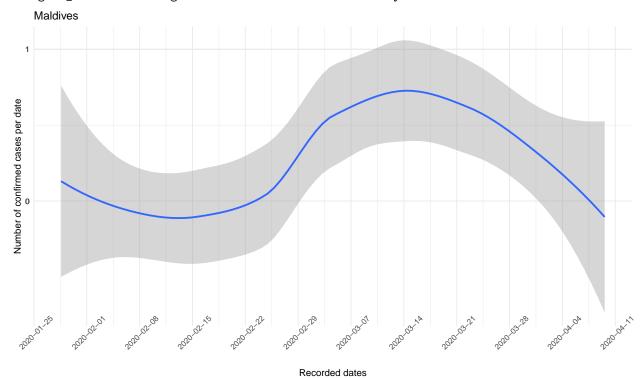
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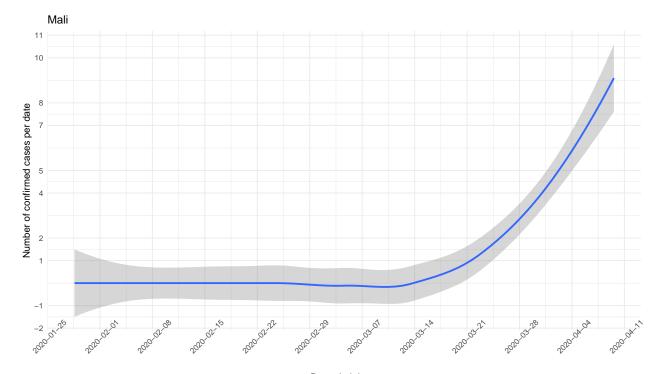
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$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

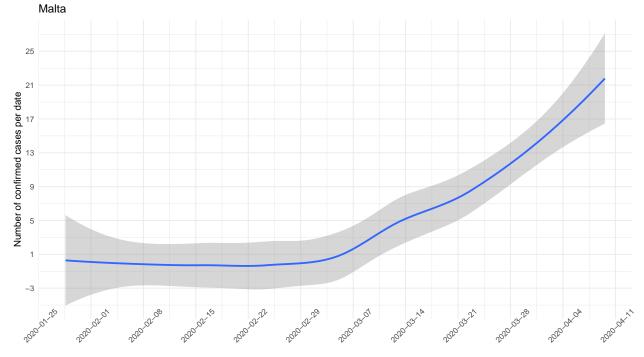


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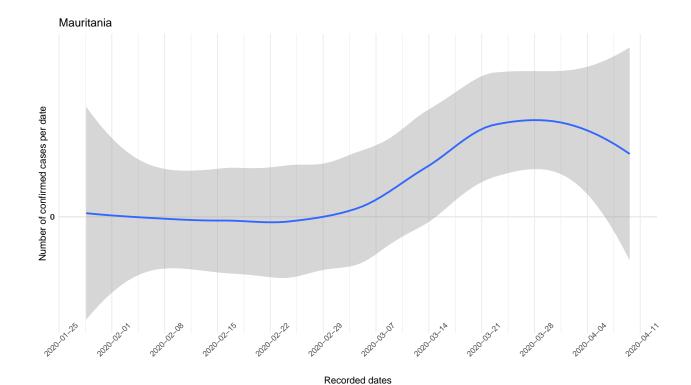


Recorded dates

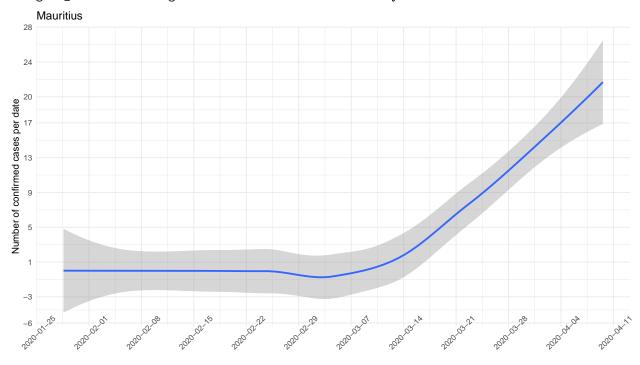
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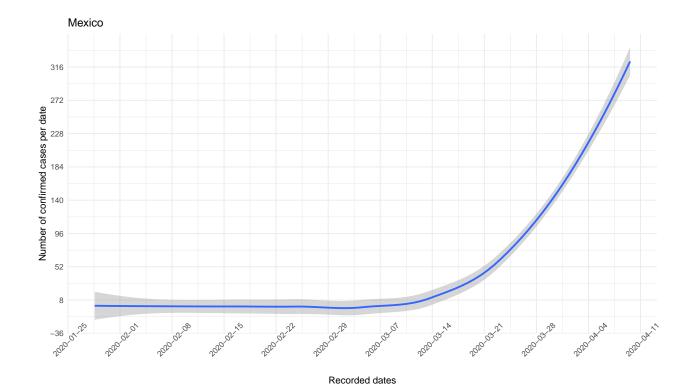
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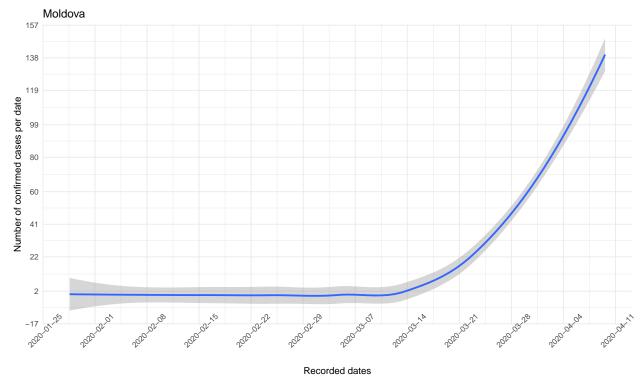
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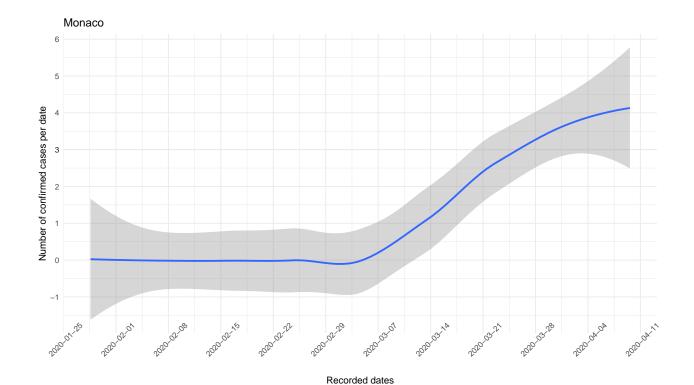
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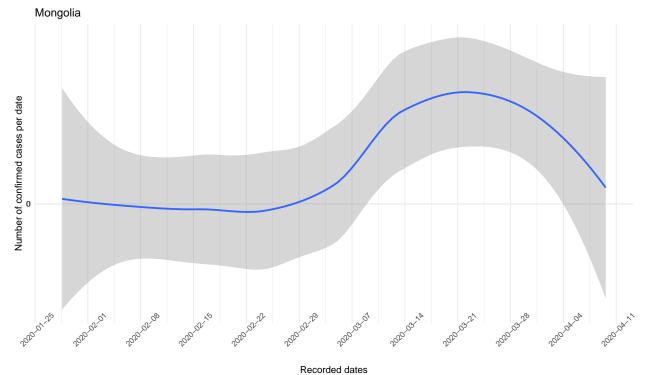
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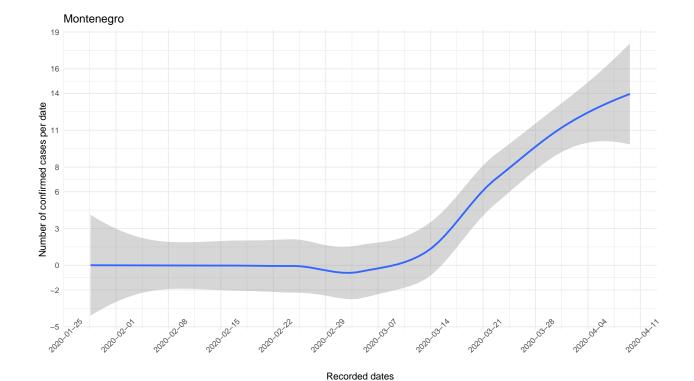
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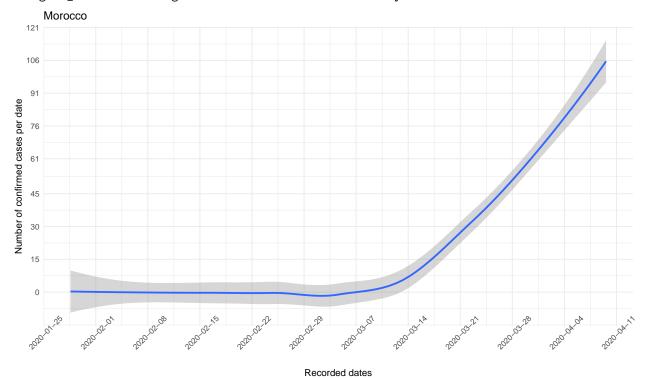
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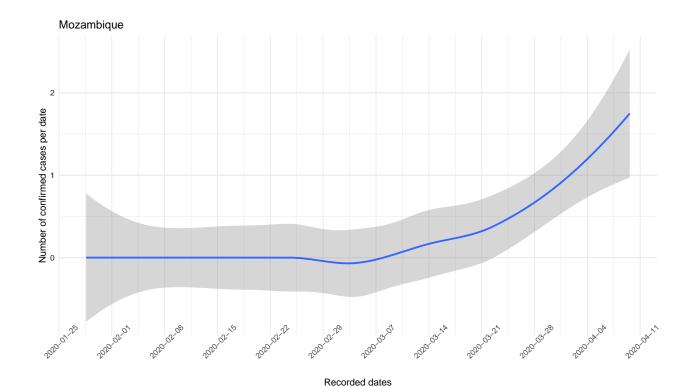
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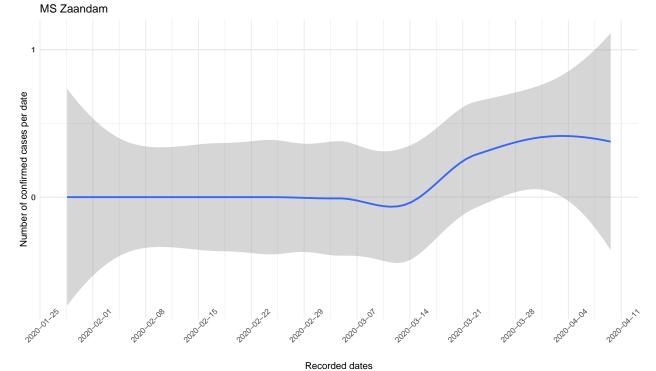
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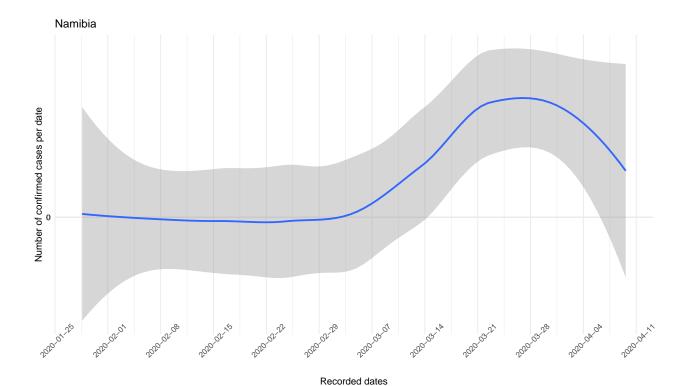
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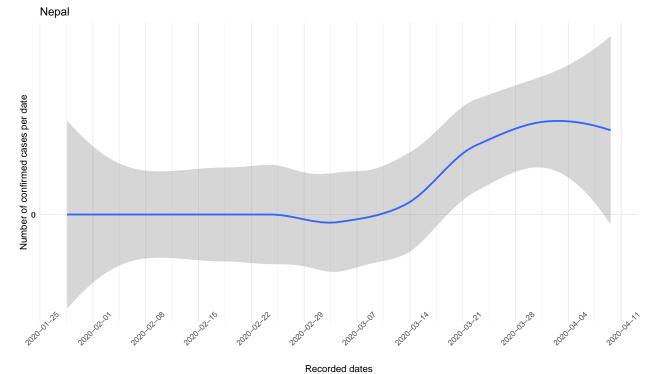
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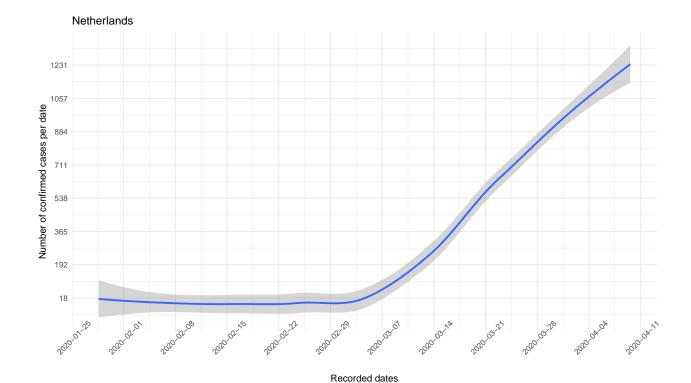
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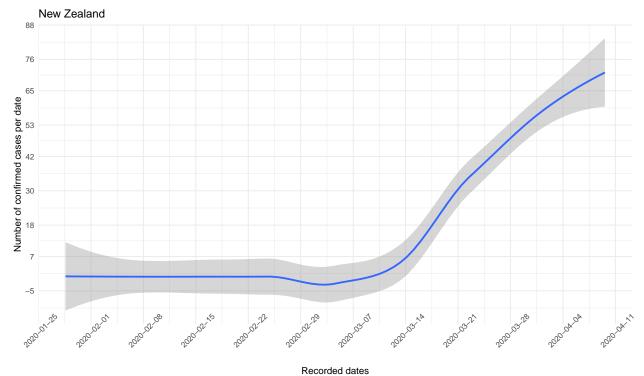
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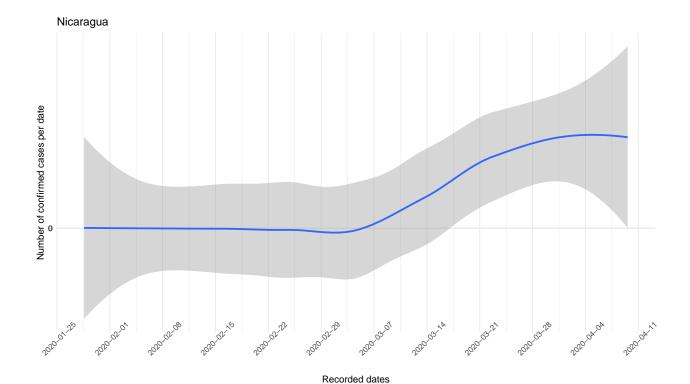
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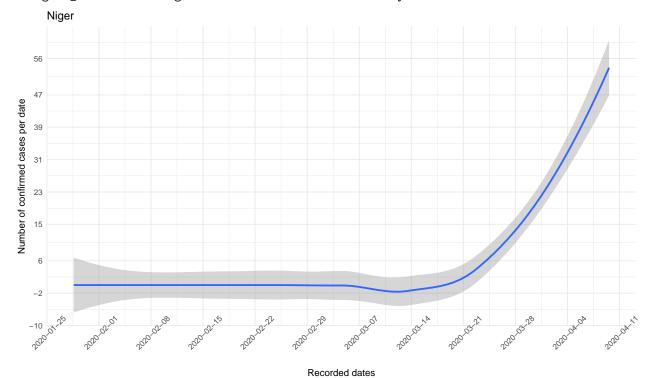
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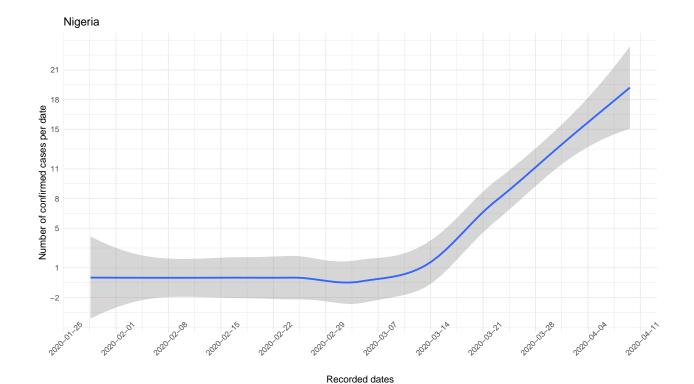
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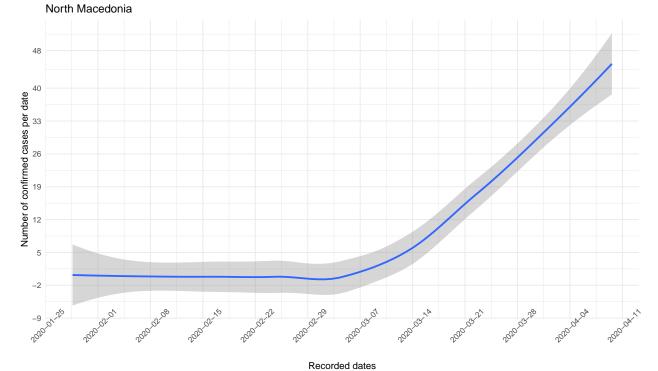
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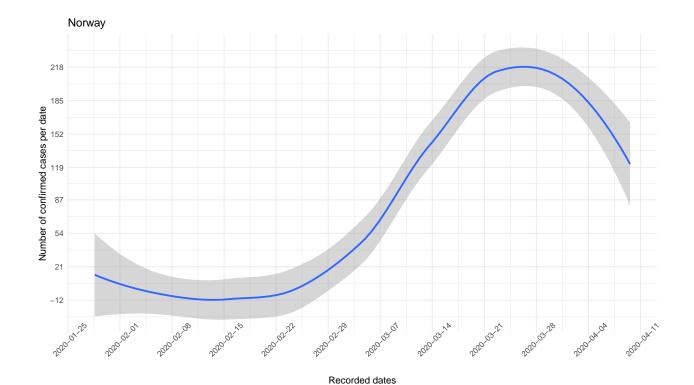
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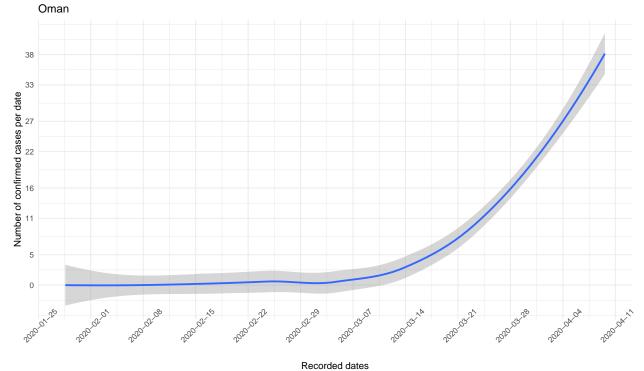
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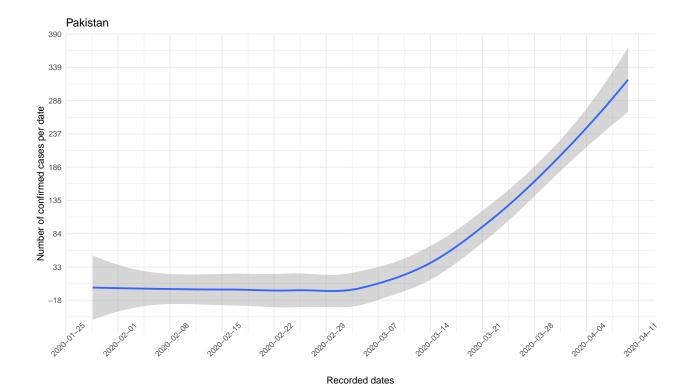
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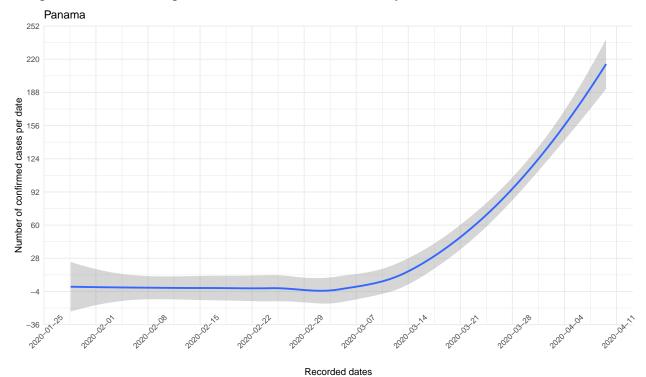
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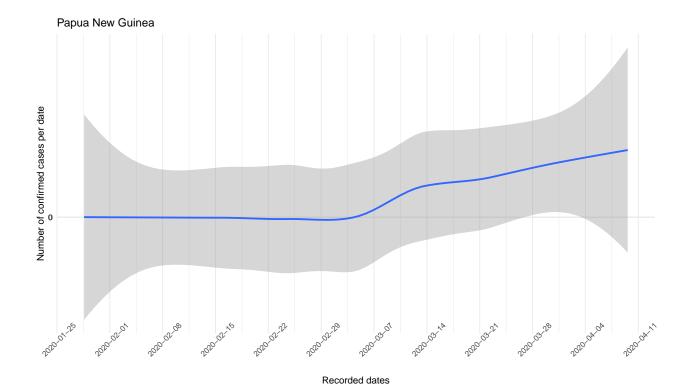
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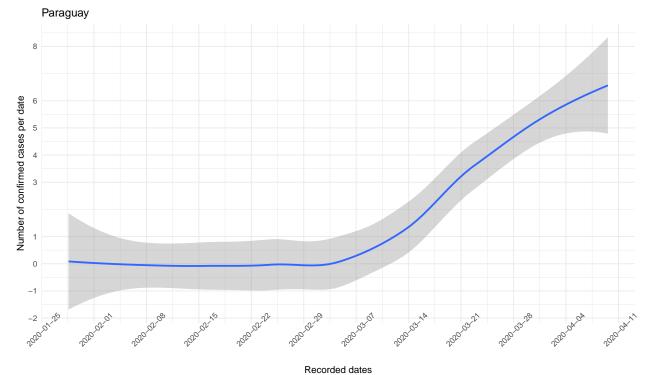
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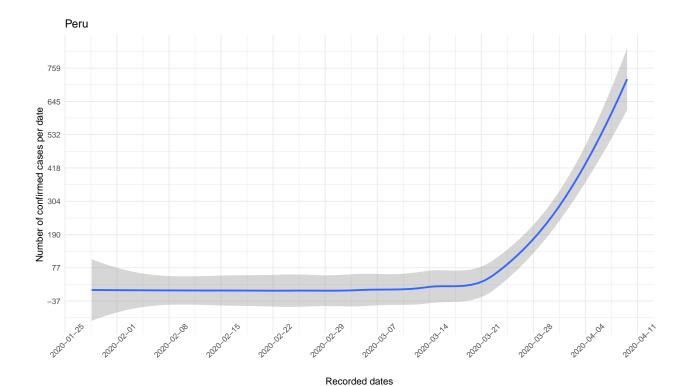
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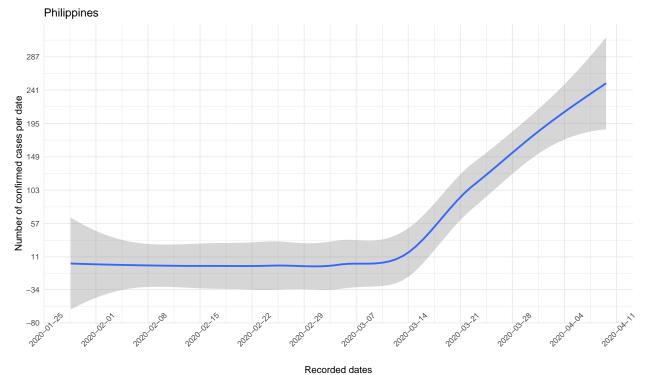
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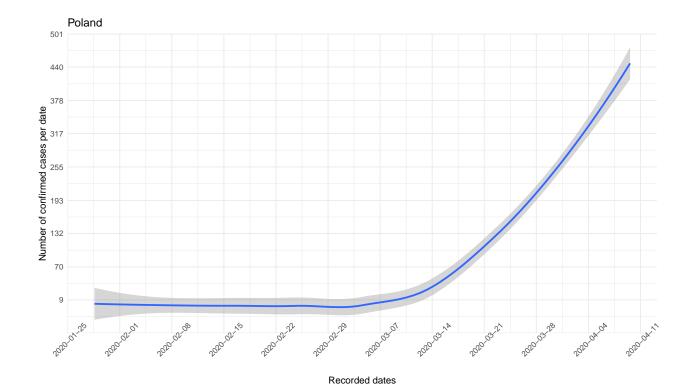
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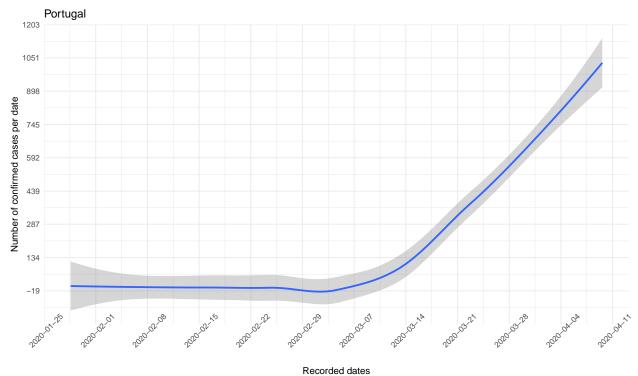
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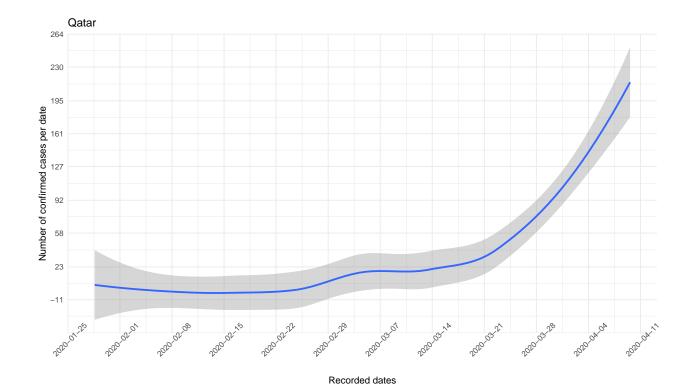
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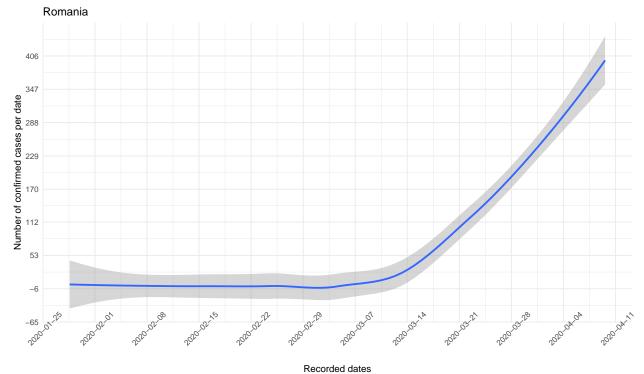
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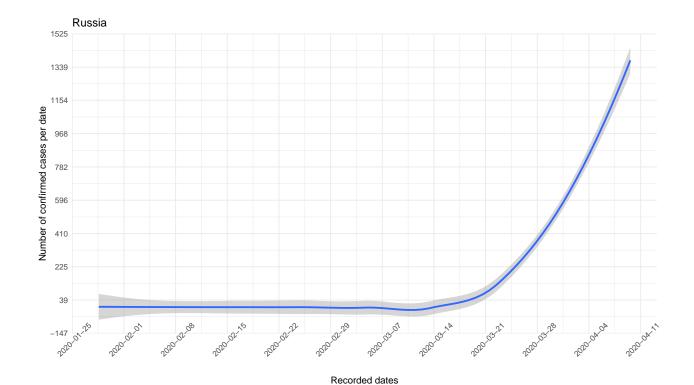
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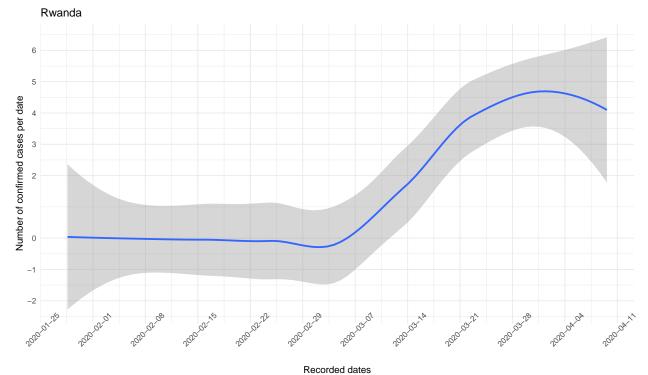
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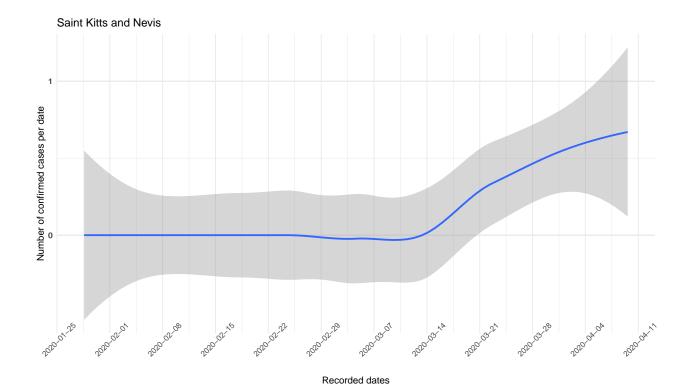
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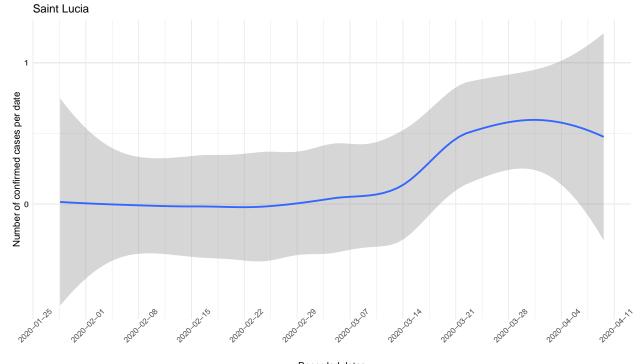
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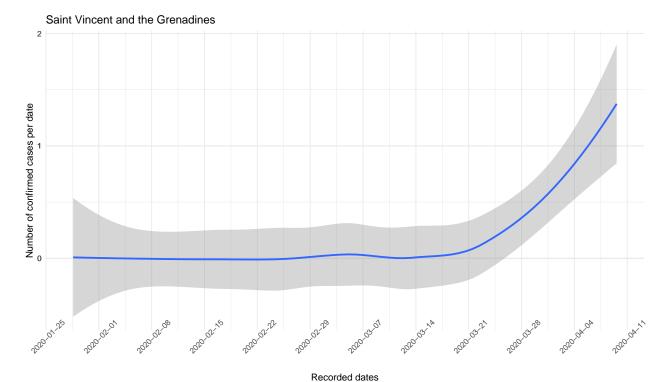
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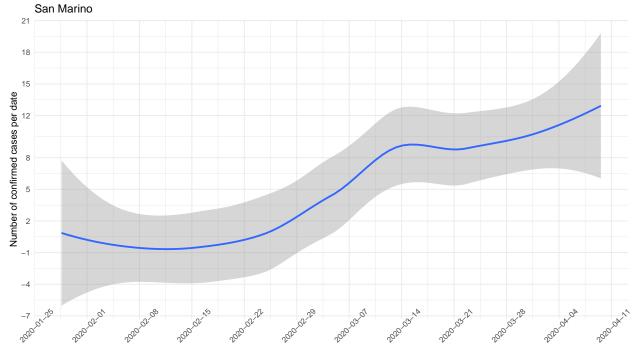


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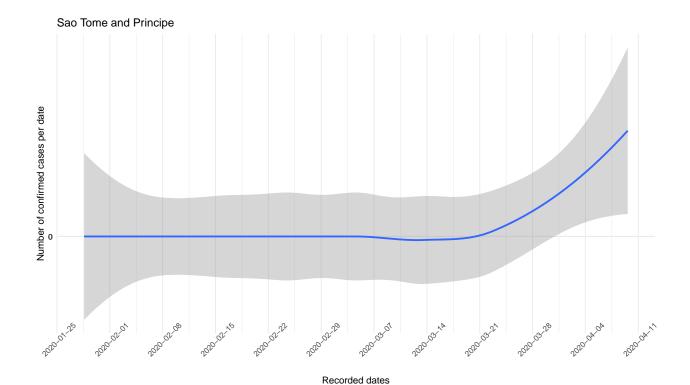


Trooblada dar

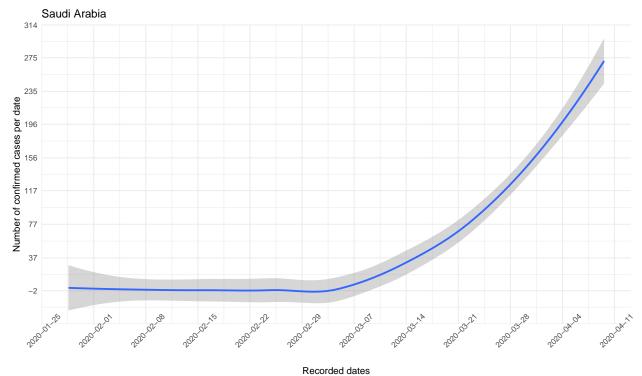
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



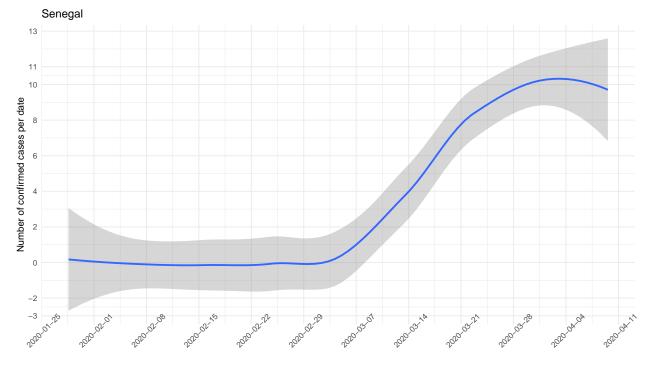
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



`geom_smooth()` using method = 'loess' and formula 'y ~ x'

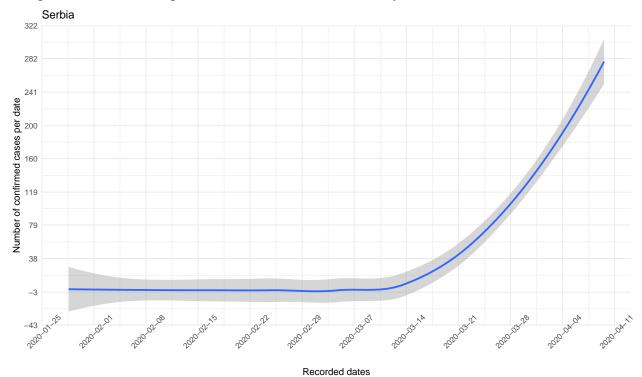


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

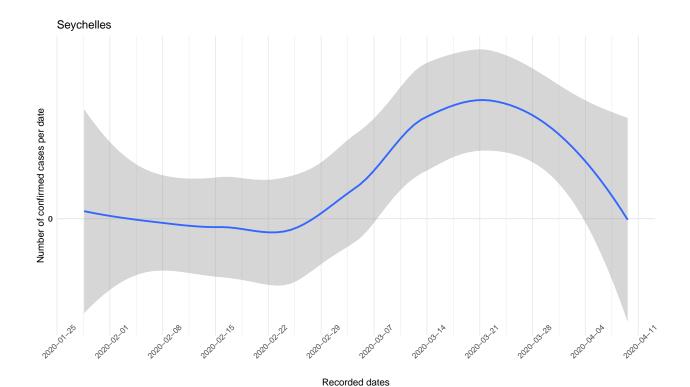


Recorded dates

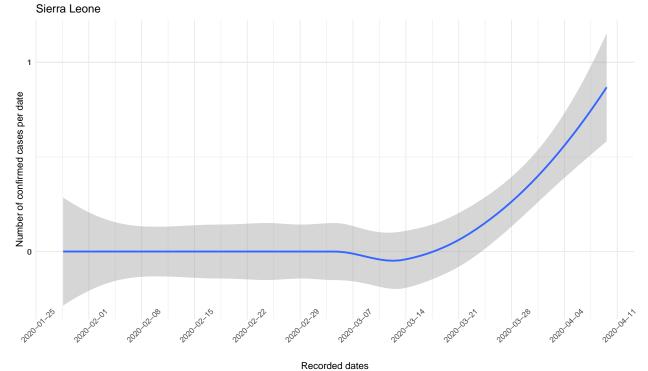
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



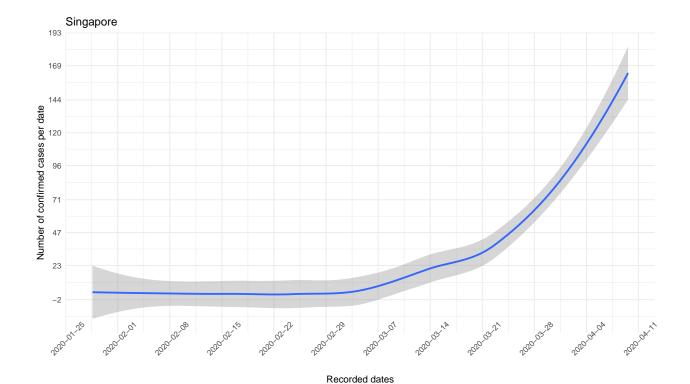
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



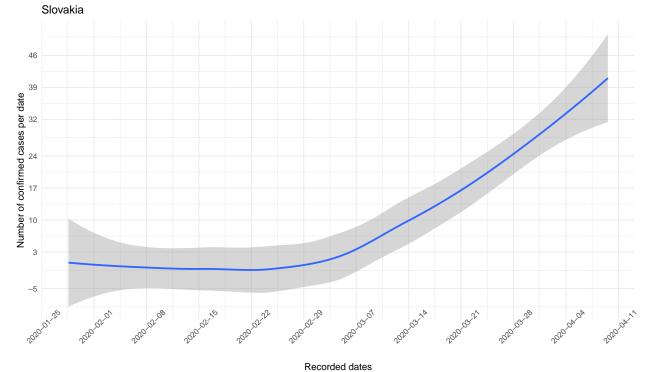
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



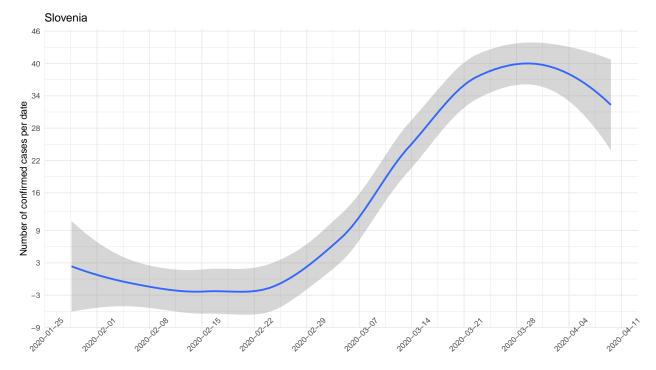
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

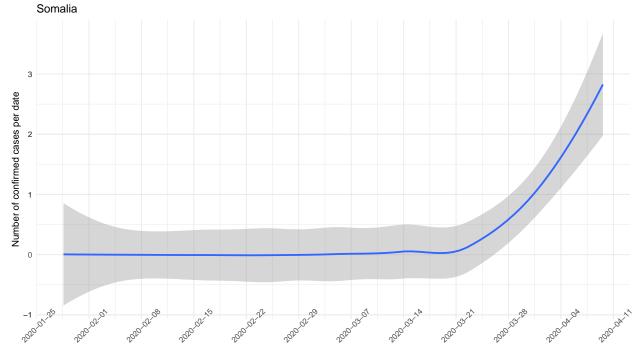


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

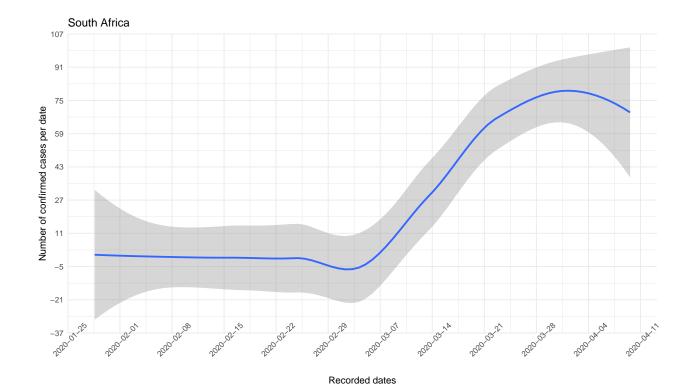


Recorded dates

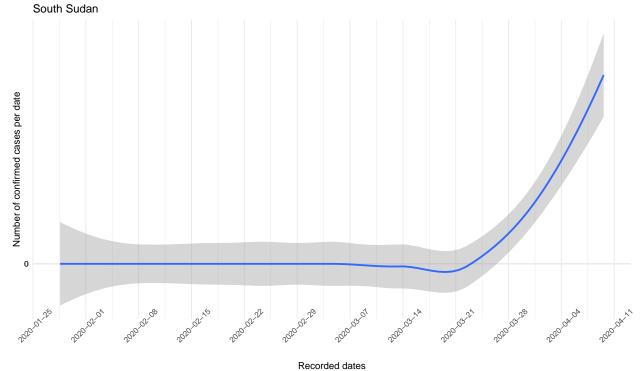
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



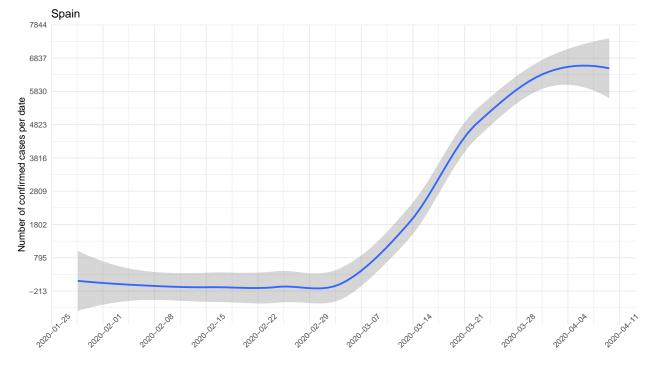
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

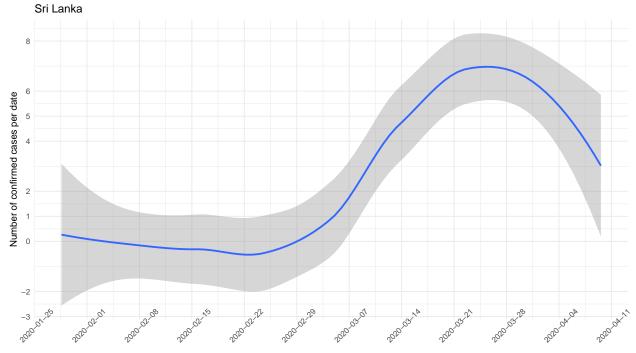


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



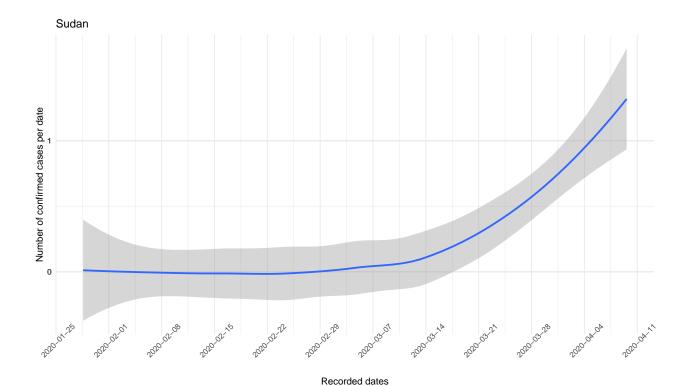
Recorded dates

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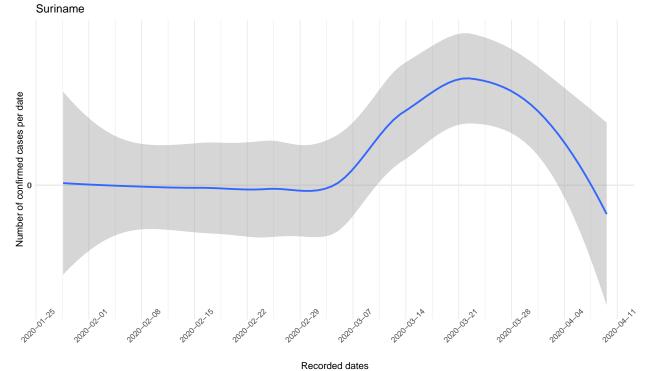


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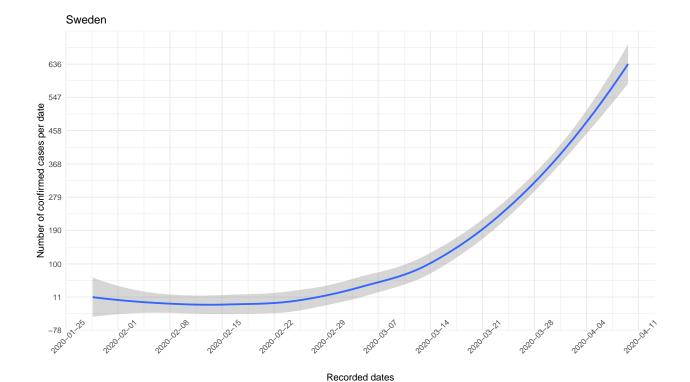
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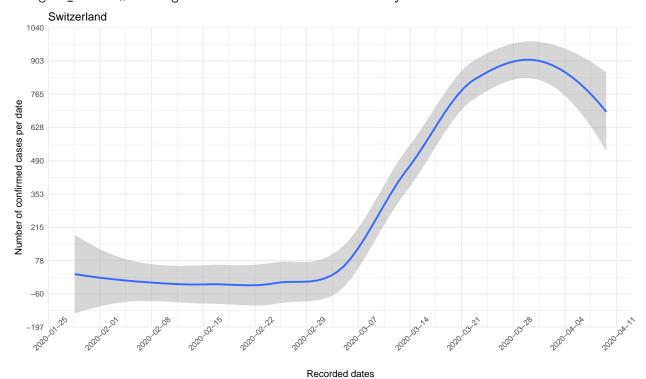
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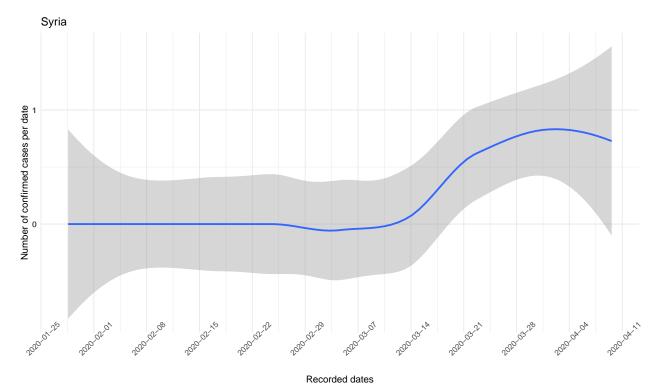
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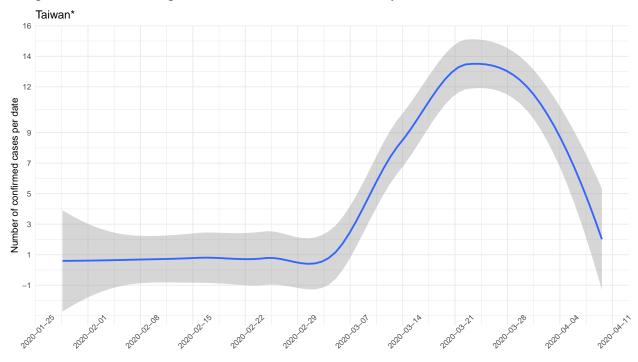
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$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

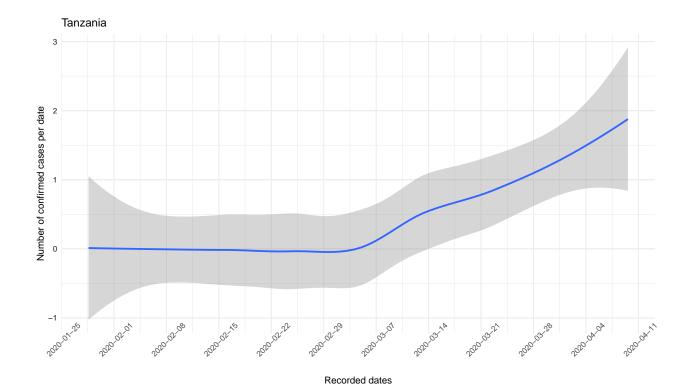


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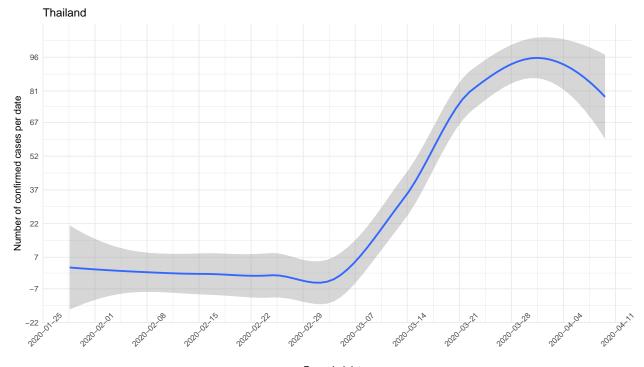


Recorded dates

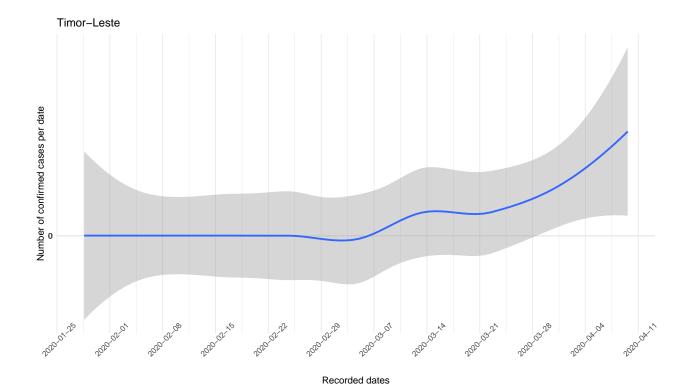
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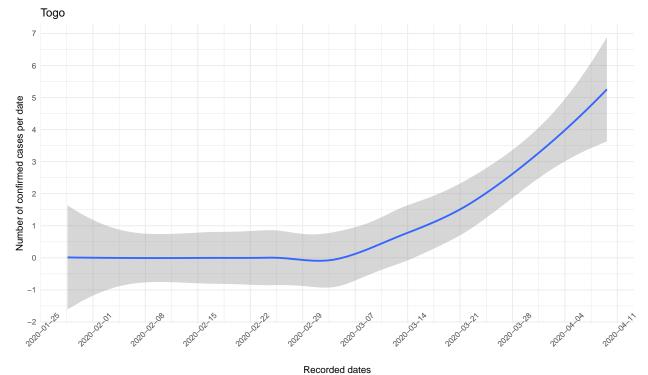
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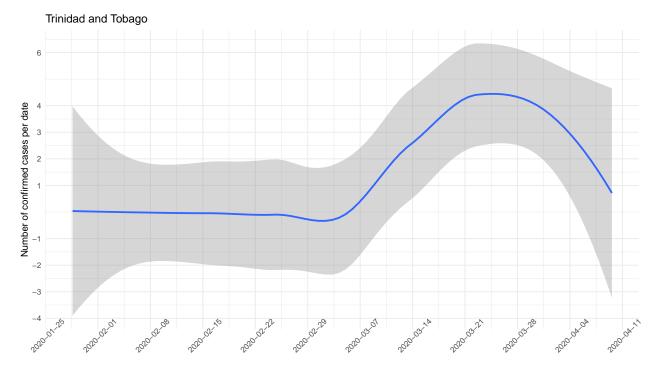
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

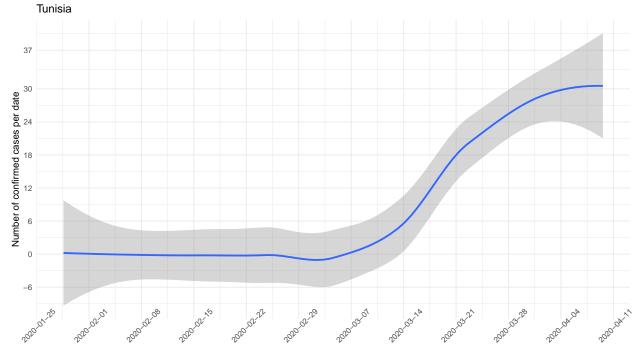


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

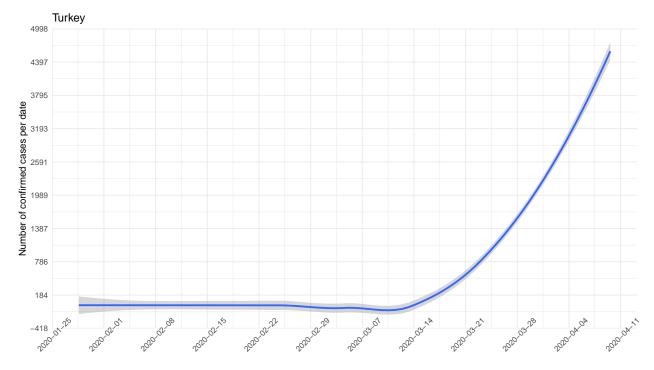


Recorded dates

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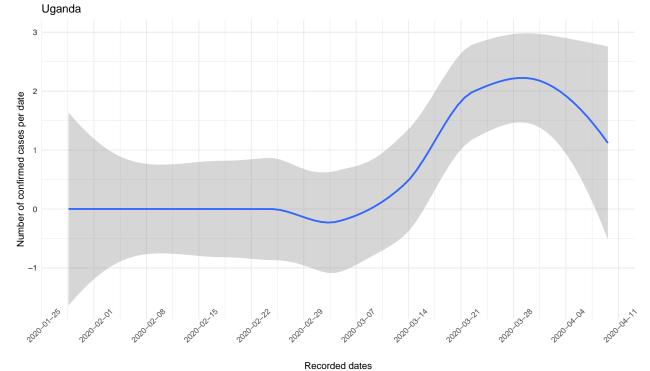


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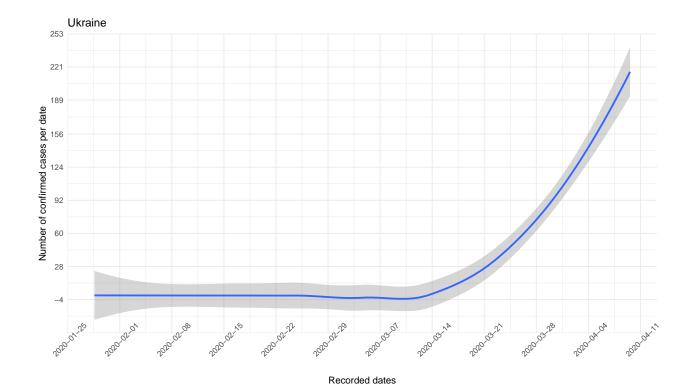


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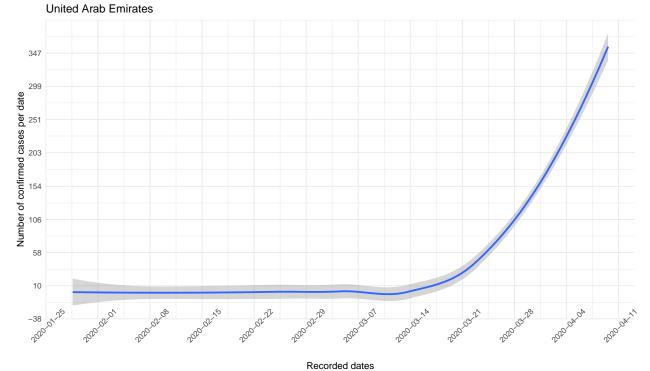
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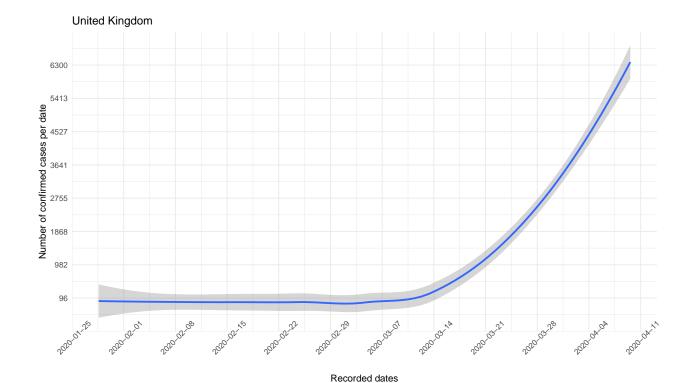
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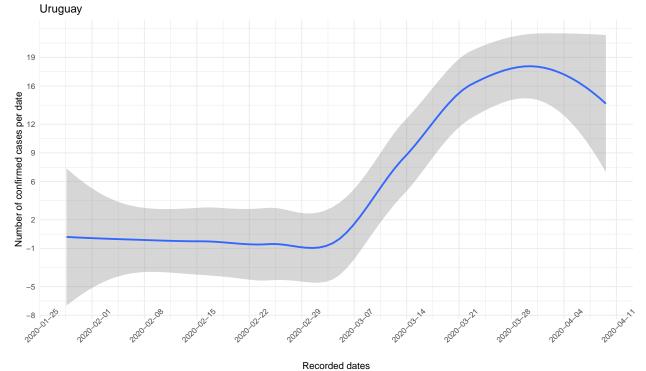
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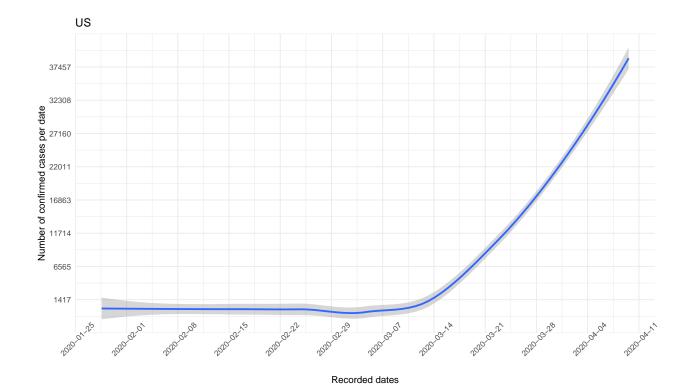
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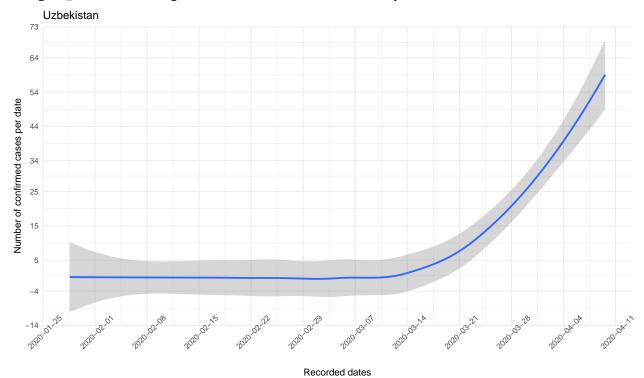
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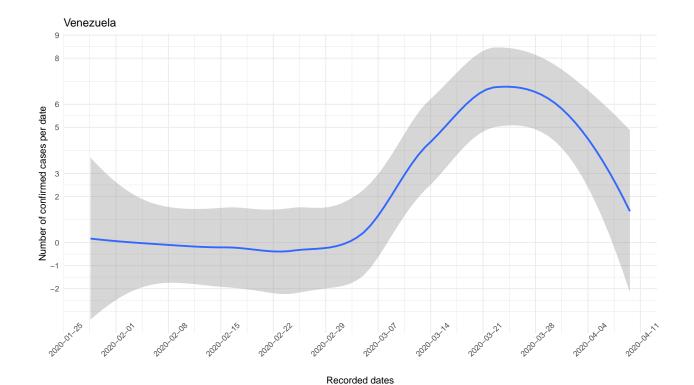
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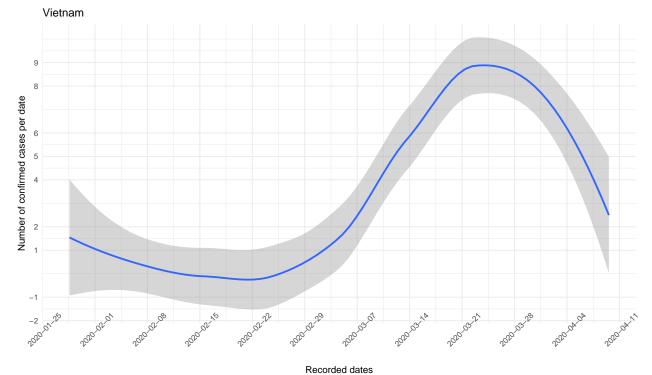
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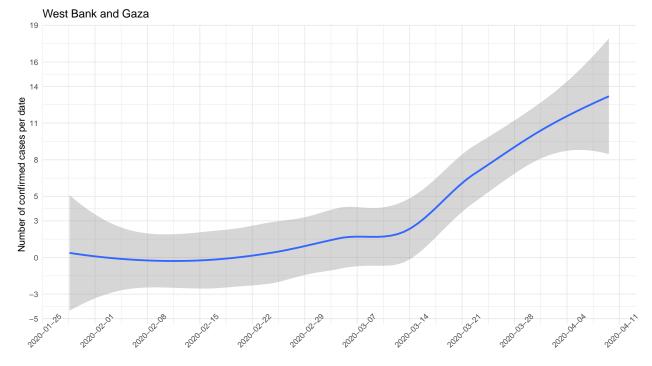
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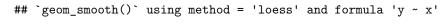
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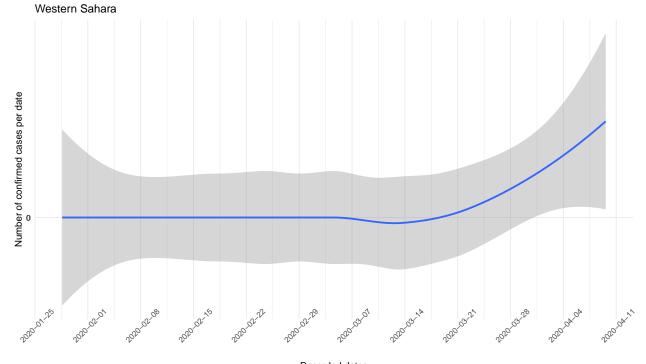


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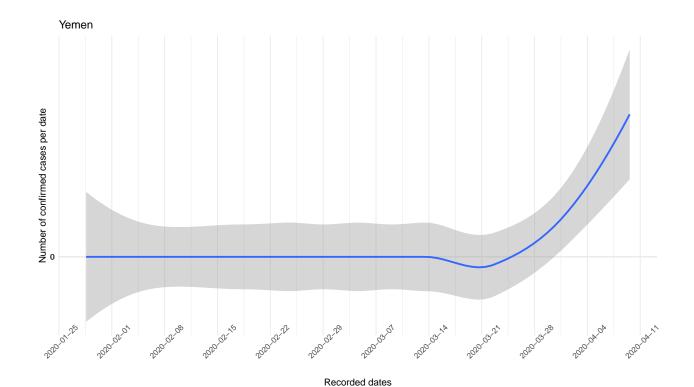
Recorded dates



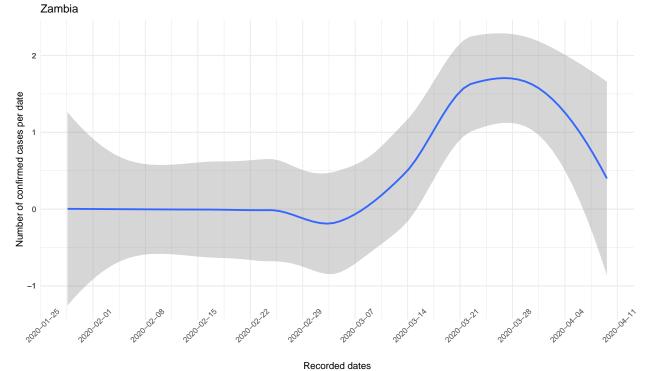


Recorded dates

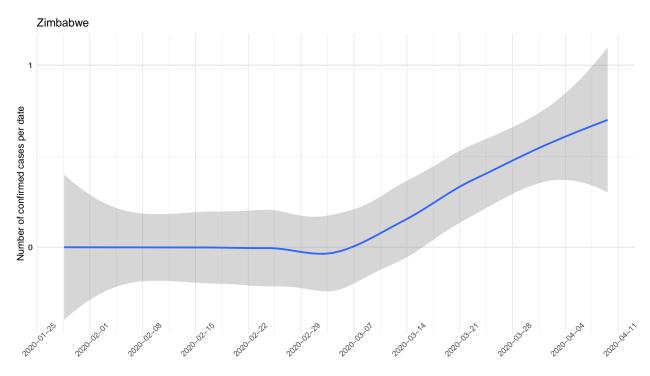
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

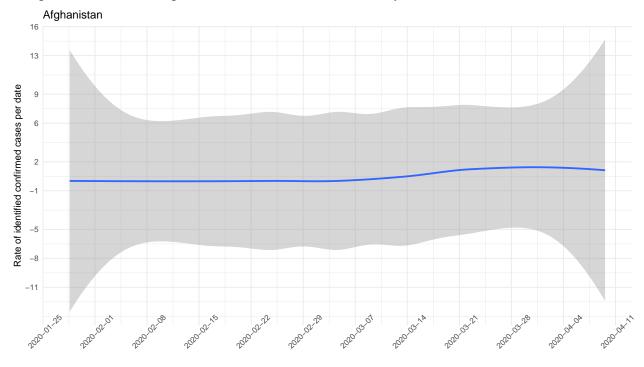


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



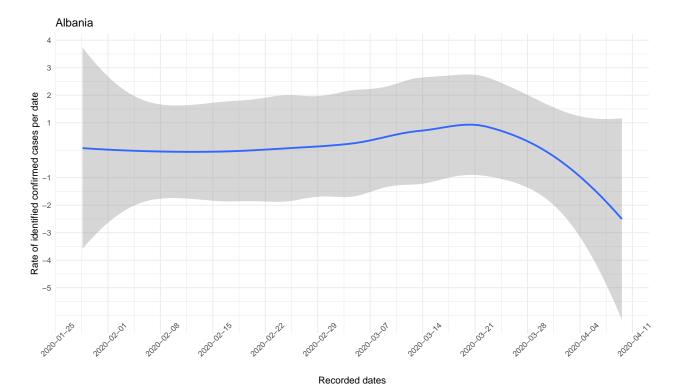
```
d5_glo <- d4_glo
cl <- makeCluster(parallel::detectCores())</pre>
registerDoParallel(cl)
tmp = foreach (i = 1:nrow(d5_glo), .combine = 'c', .inorder=T) %dopar% {
  cty = as.character(d4_glo[i,'Country/Region'])
  dt = d4_glo [i, 'dated']
  dts = d4_glo[order(as.Date(d4_glo[which(d4_glo$`Country/Region` == cty), 'dated'])), 'dated']
  dt_pos = which(dts == dt)
  if (dt_pos > 1){
   prev_dt = dts[dt_pos-1]
    d4_glo[i,'n_bydate'] - d4_glo[which(d4_glo[,'Country/Region'] == cty &
                                                    d4_glo[,'dated'] == prev_dt),'n_bydate']
  }else{
    0
  }
}
stopCluster(cl)
d4_glo$n_rate_bydate = unlist(tmp)
cty_uq = unique(d4_glo$`Country/Region`)
for (i in 1:length(cty_uq)) {
  df <- d4_glo %>% filter(`Country/Region` == cty_uq[i])
 plt <- ggplot(df, aes(dated, n_rate_bydate)) +</pre>
  geom smooth() +
  ggtitle(cty_uq[i]) +
  scale_x_date('Recorded dates',
```

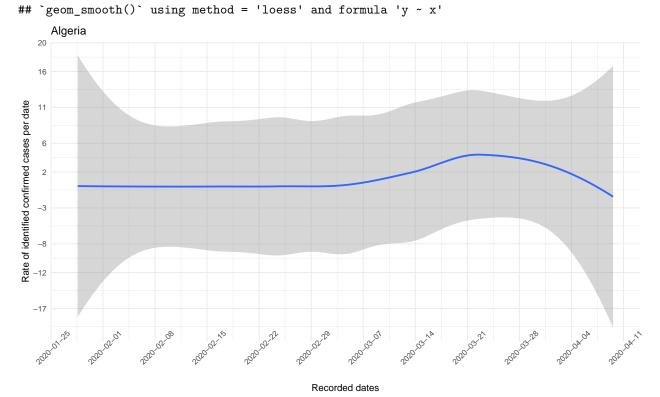
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



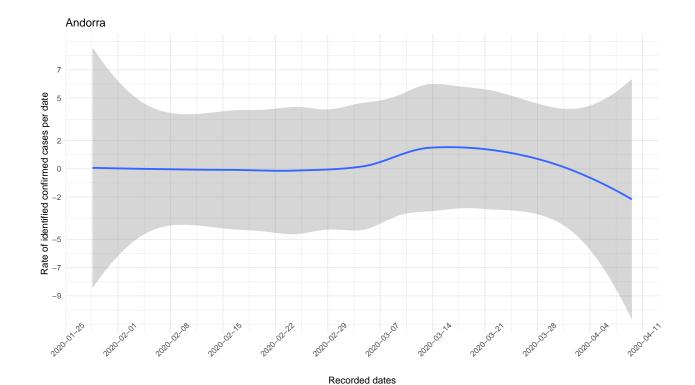
Recorded dates

`geom_smooth()` using method = 'loess' and formula 'y ~ x'

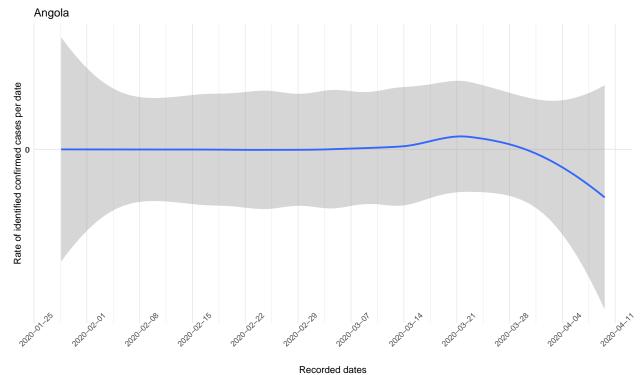




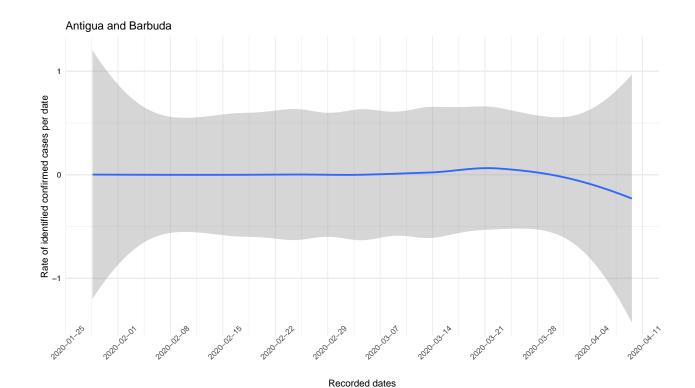
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



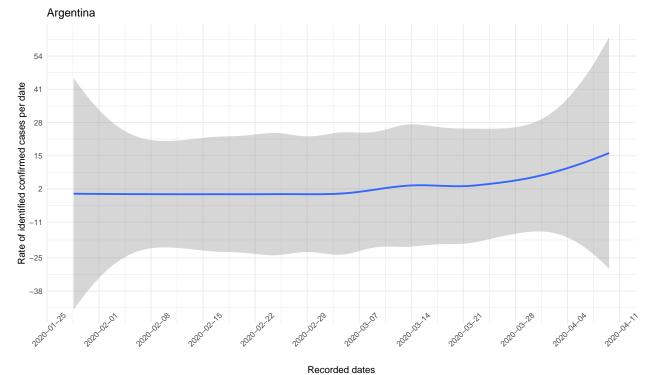
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



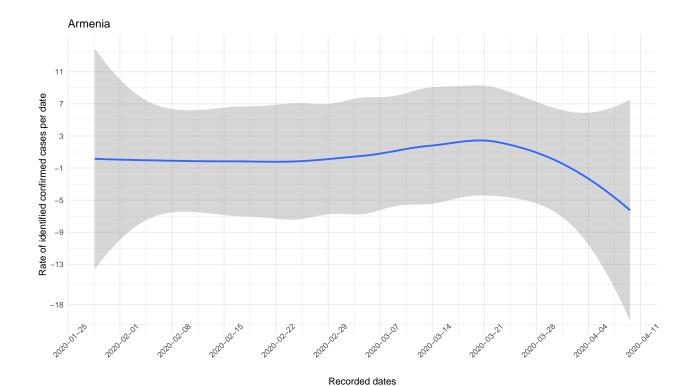
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



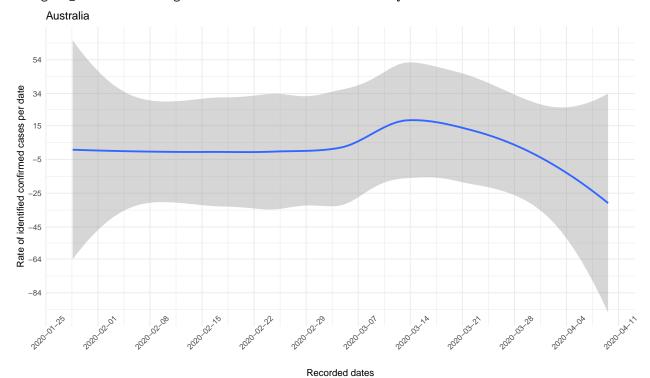
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



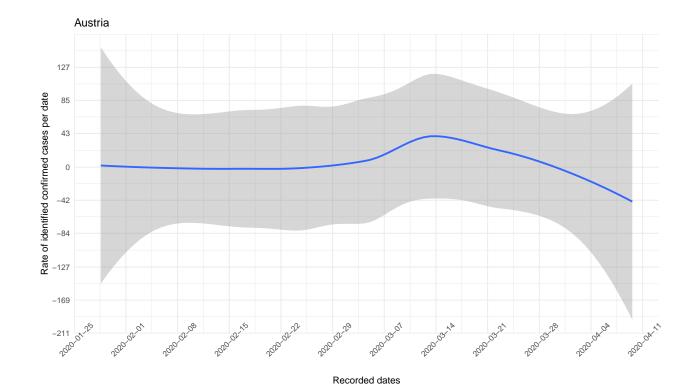
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



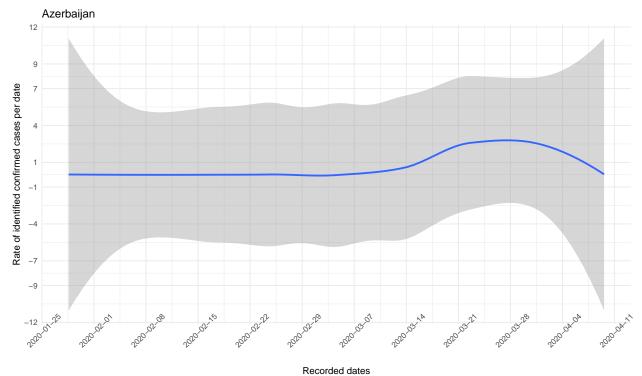
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



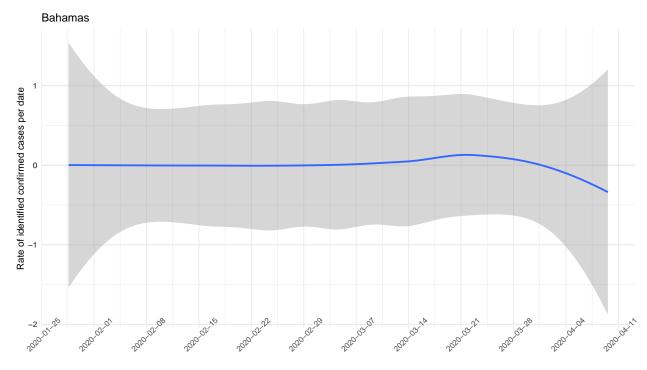
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



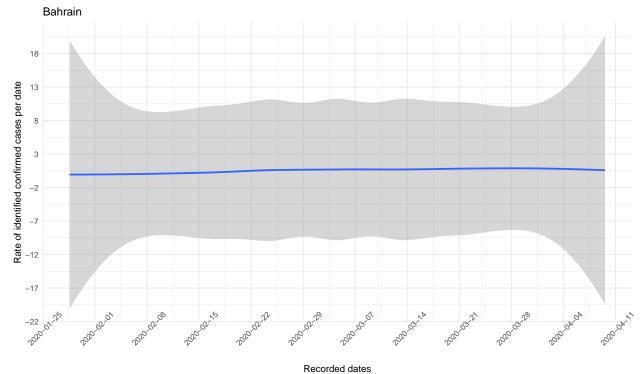
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

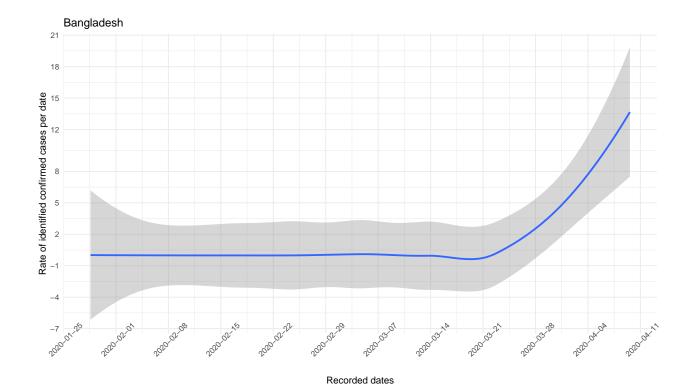


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

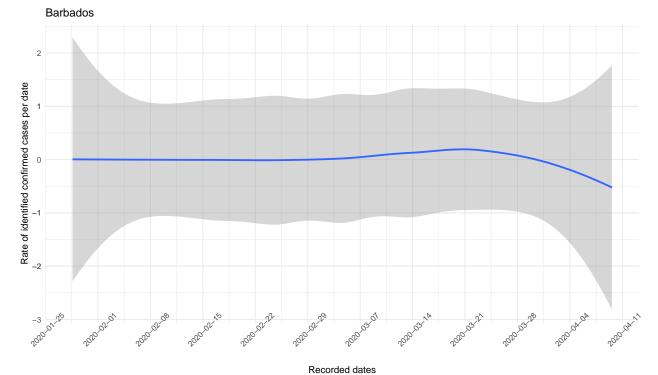


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

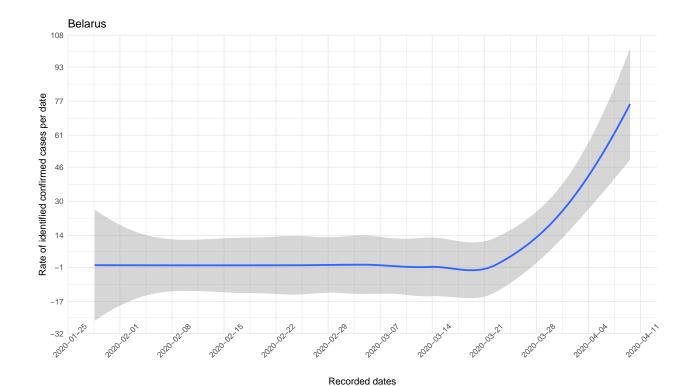




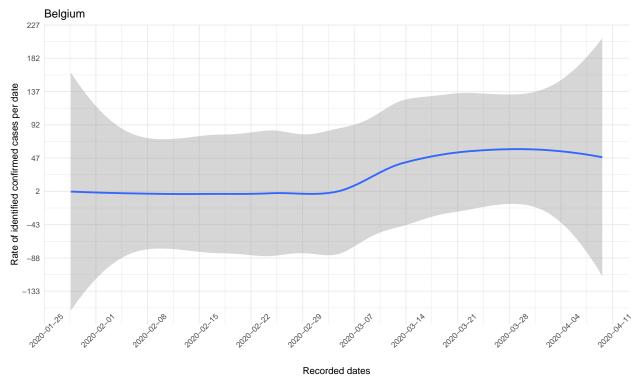
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



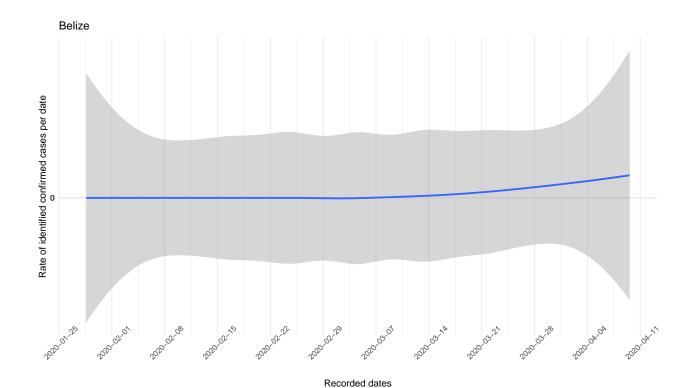
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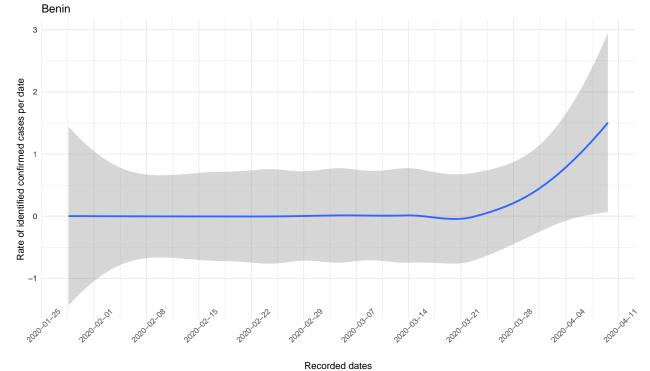
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



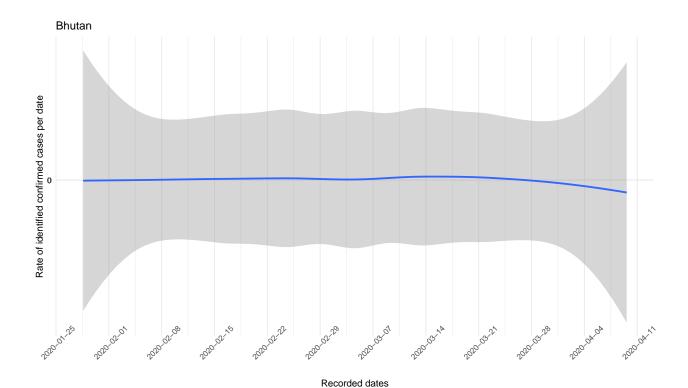
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



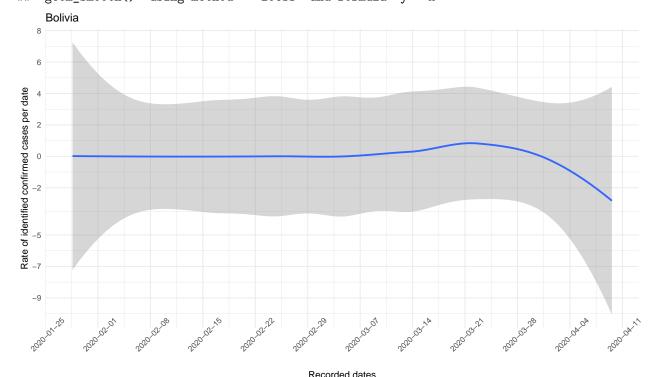
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



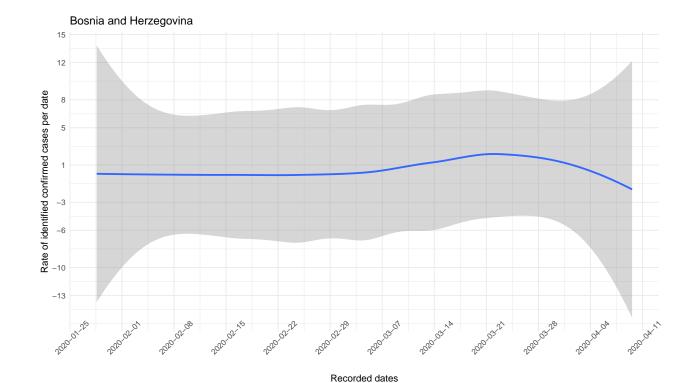
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



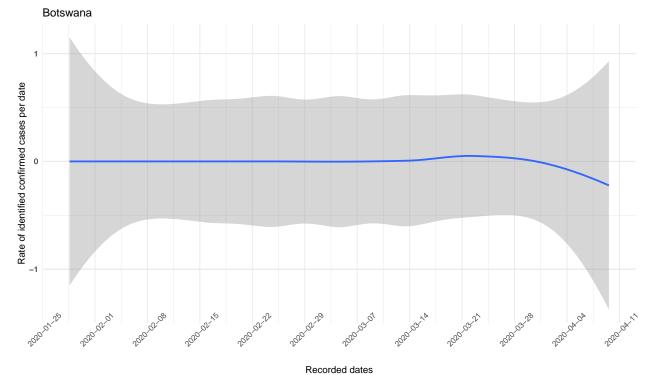
`geom_smooth()` using method = 'loess' and formula 'y ~ x'



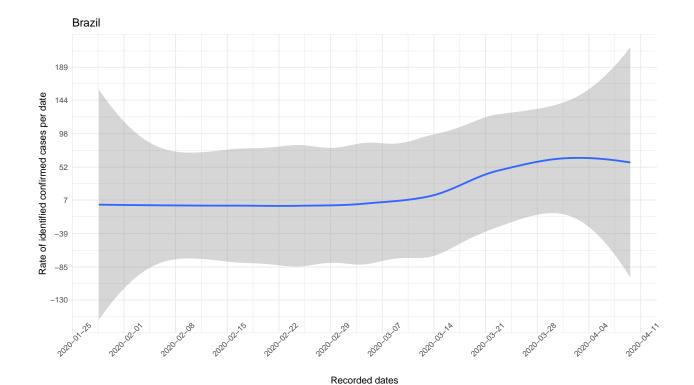
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



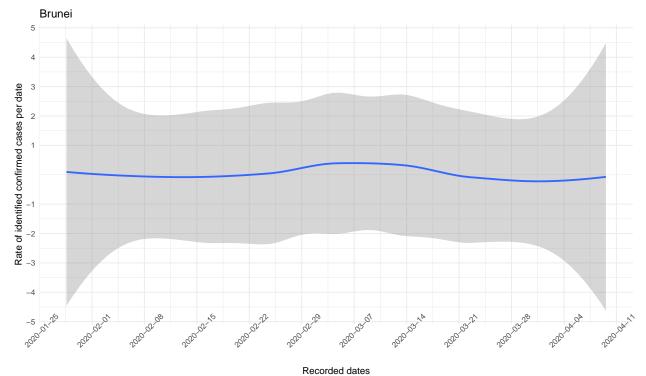
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



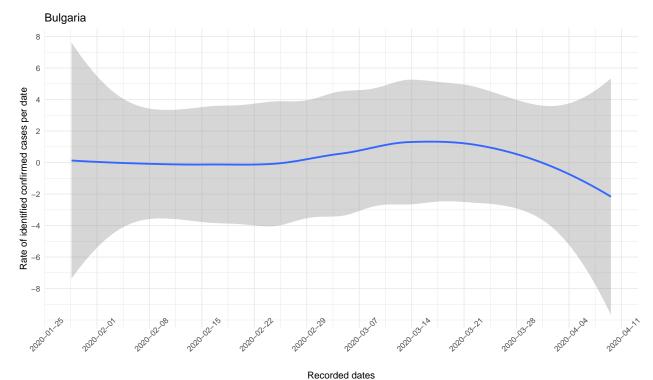
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



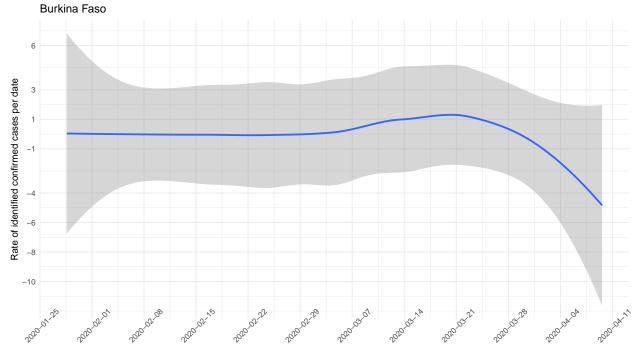
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



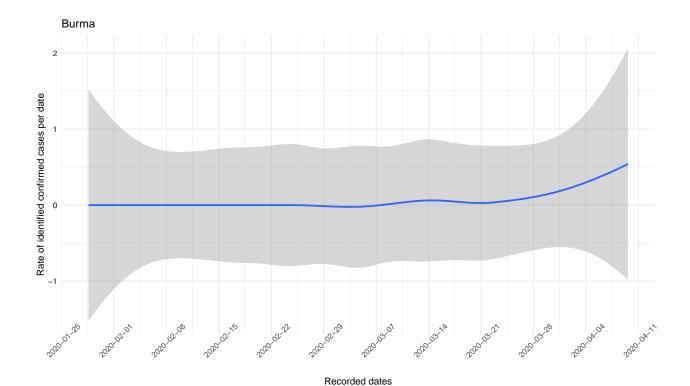
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

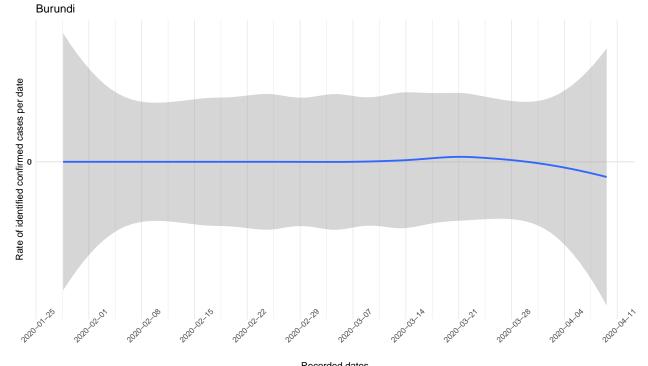


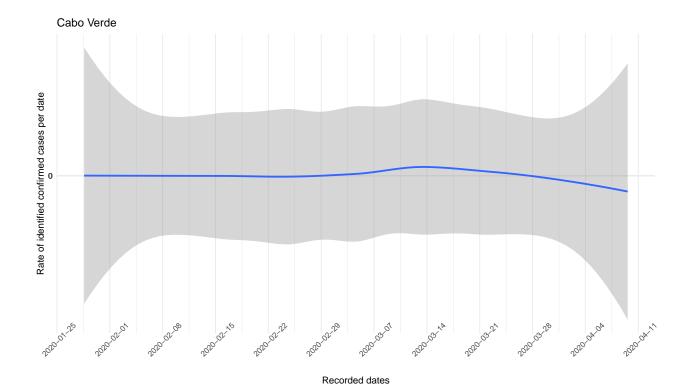
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



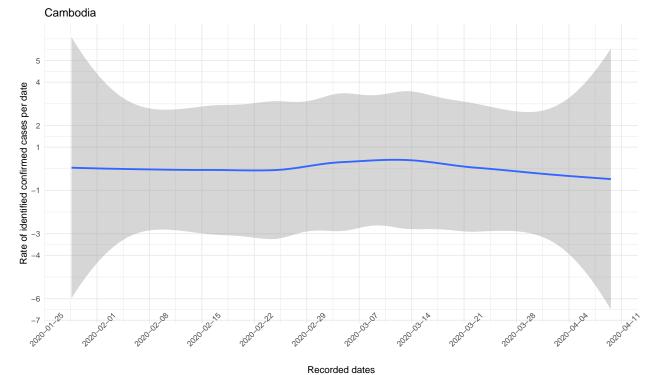
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



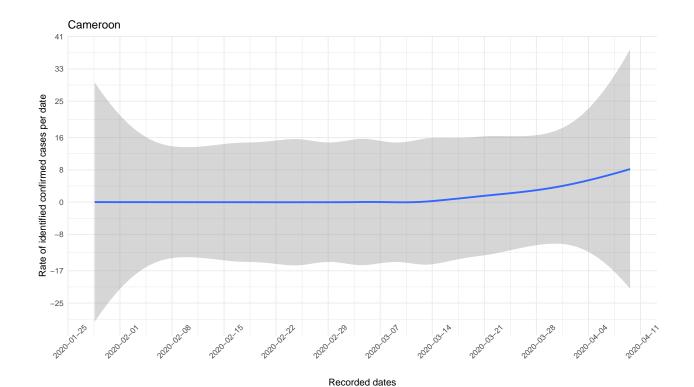




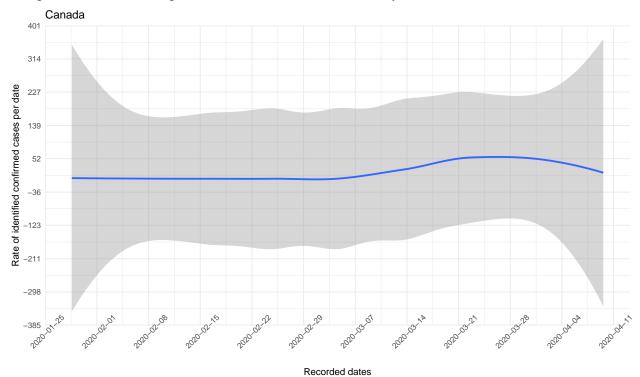
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



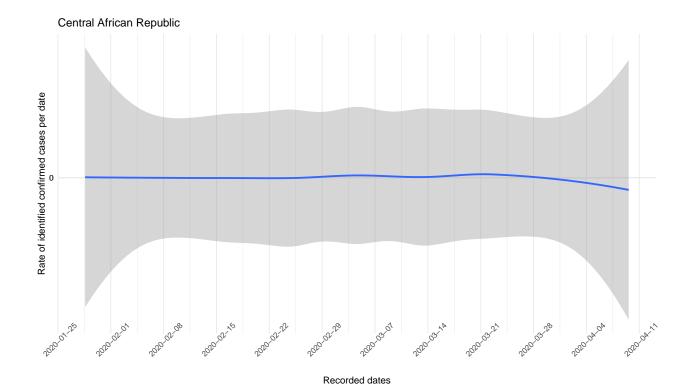
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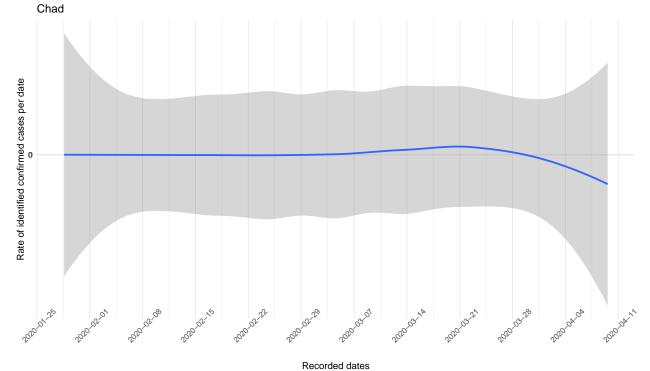
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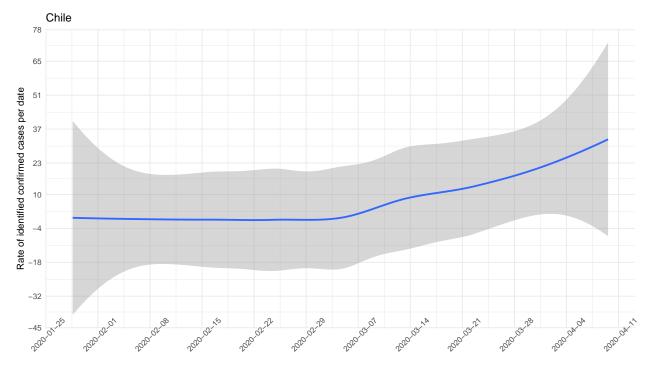
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`geom_smooth()` using method = 'loess' and formula 'y ~ x'

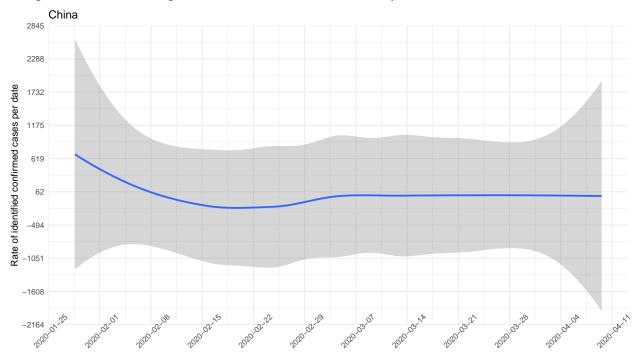


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



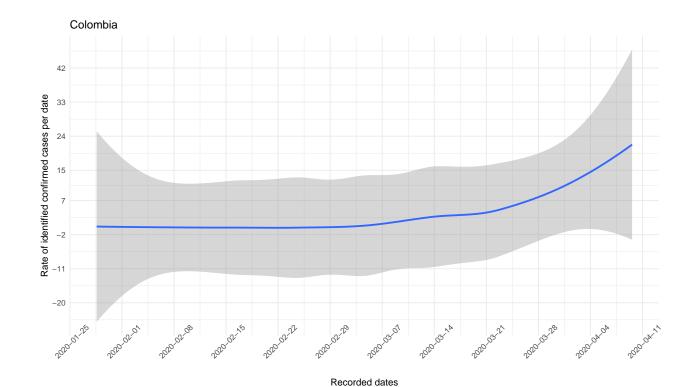
Recorded dates

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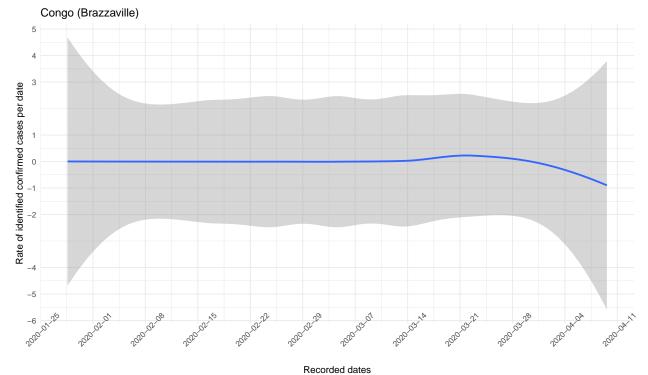


Recorded dates

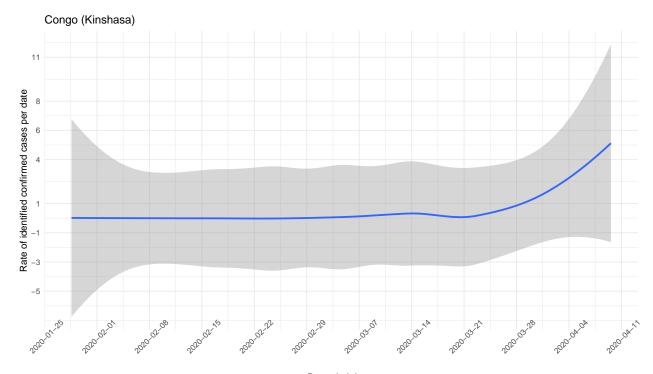
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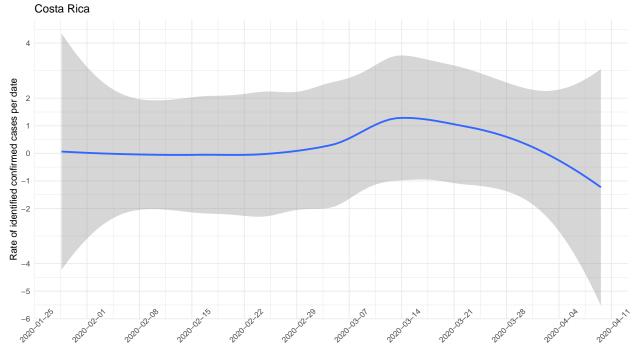
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



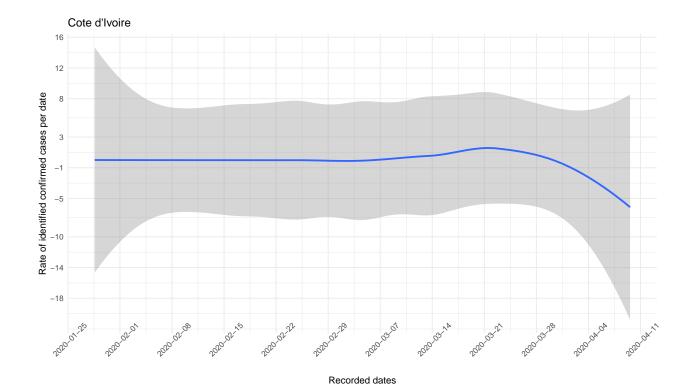
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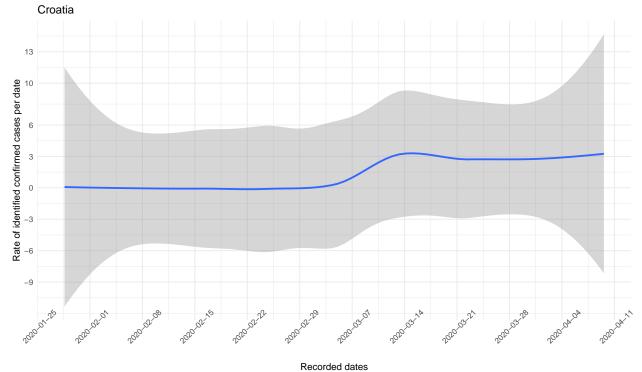
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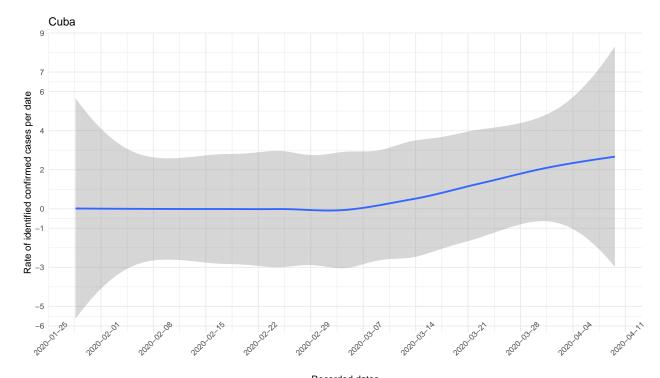
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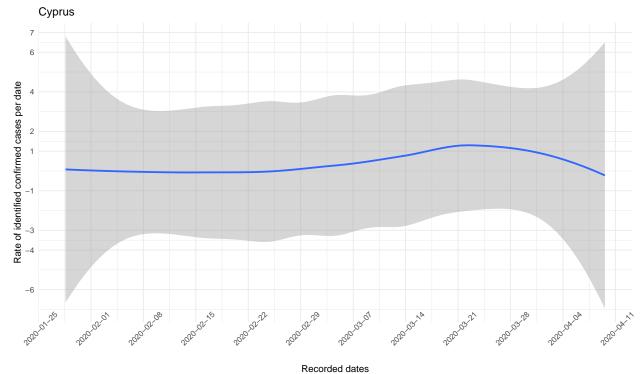
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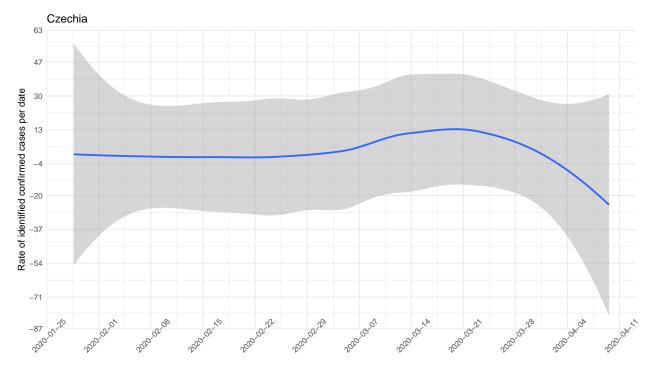
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Recorded dates

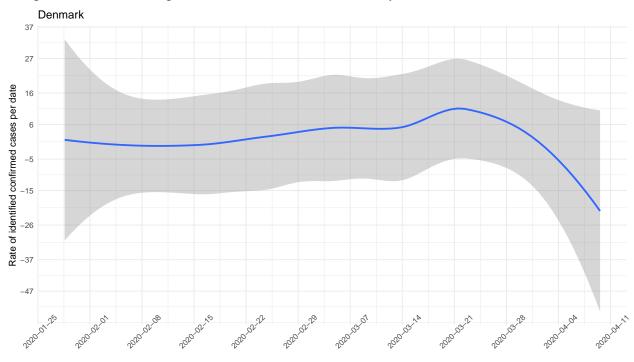


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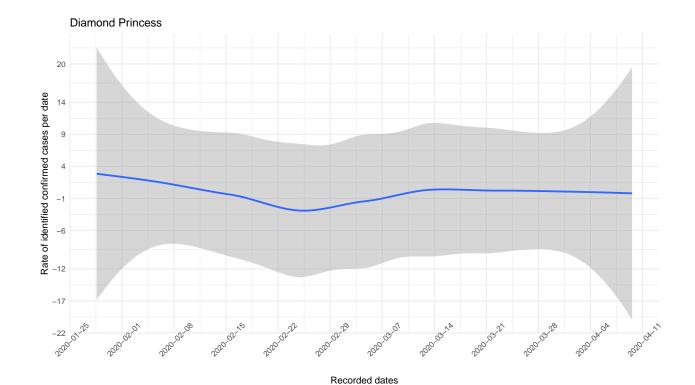


Recorded dates

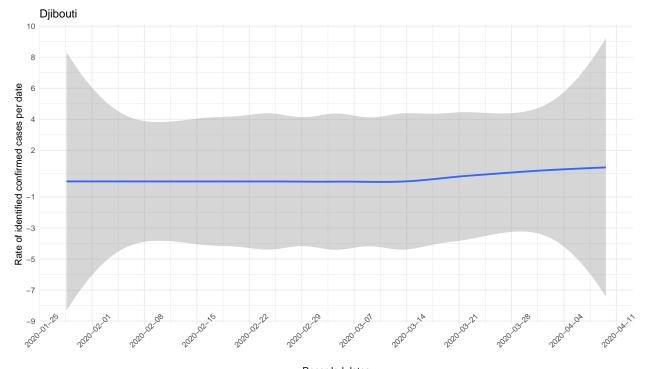
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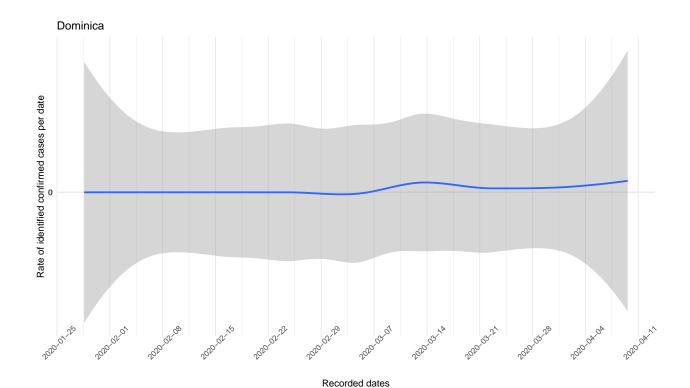
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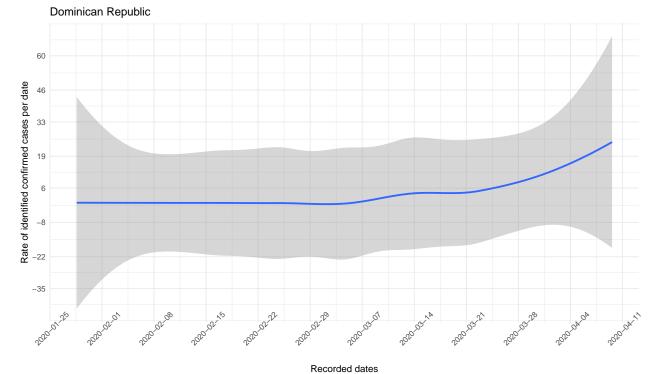
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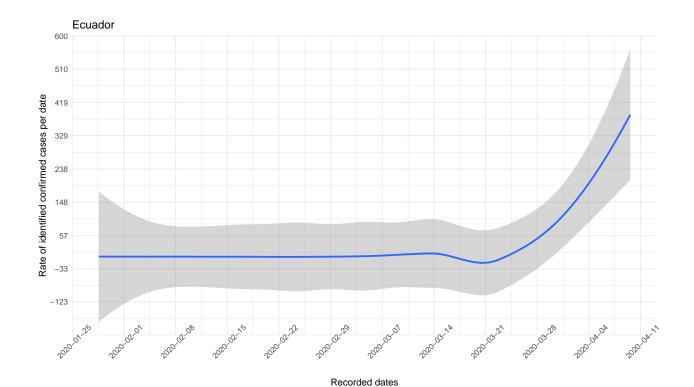
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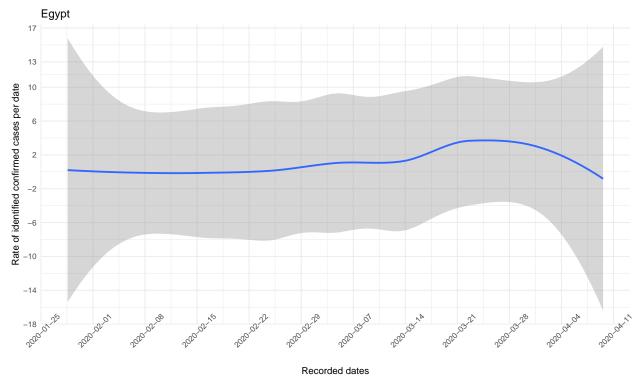
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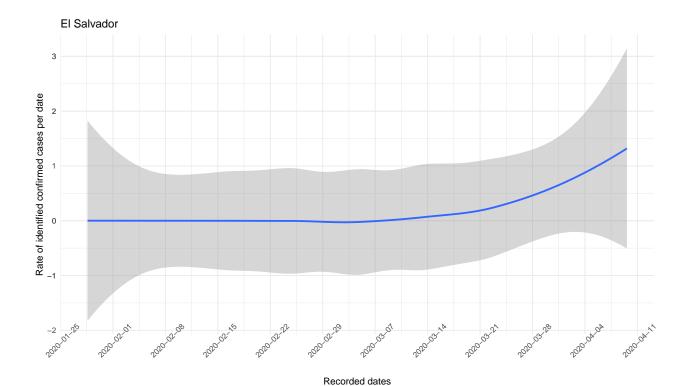
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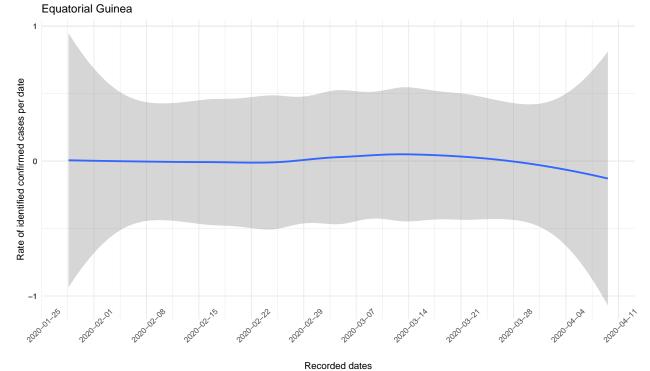
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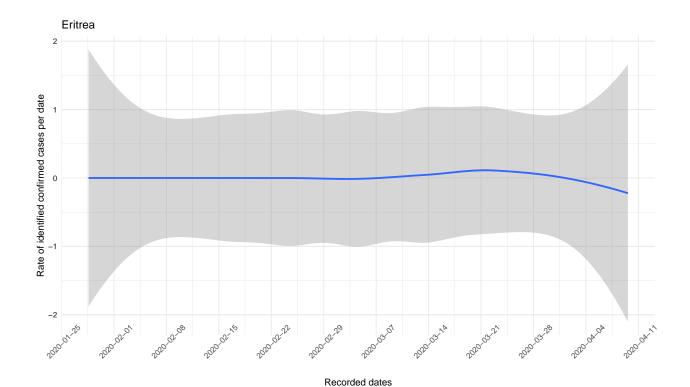
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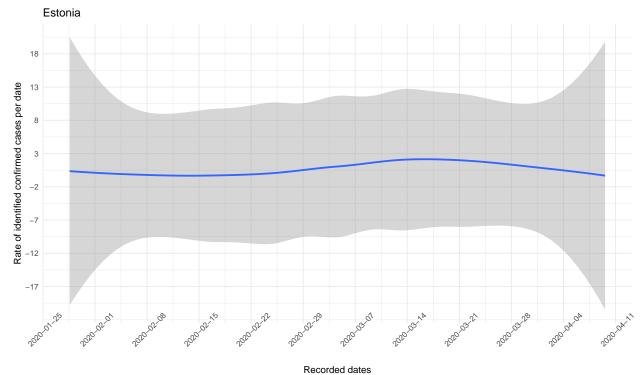
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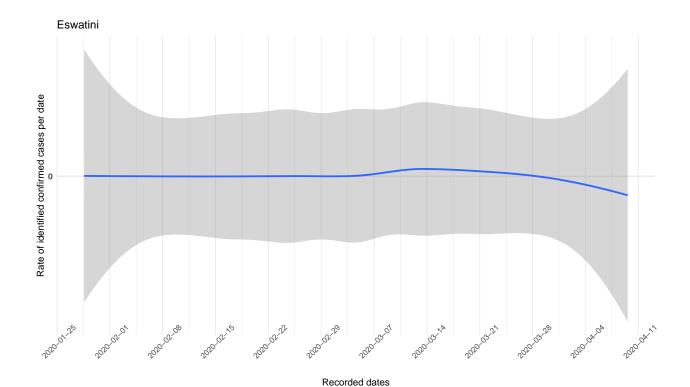
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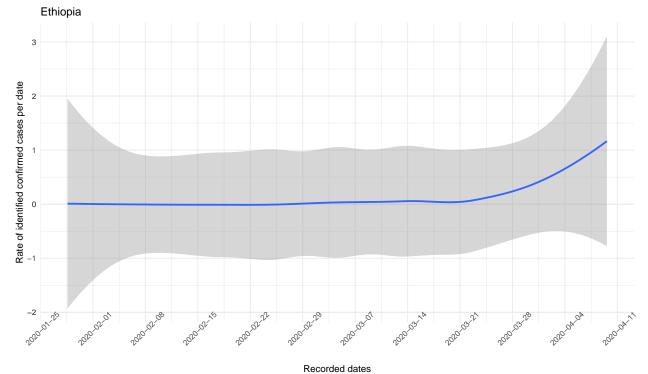


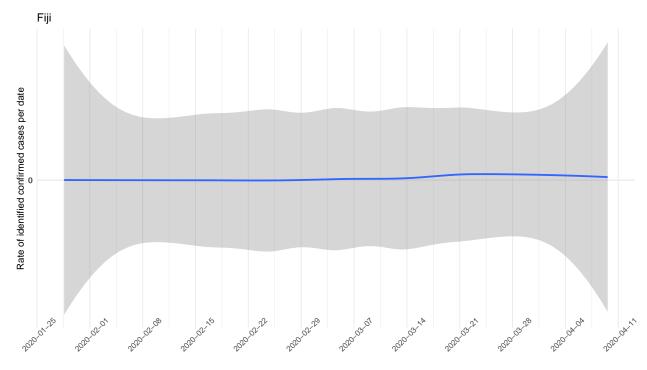
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$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

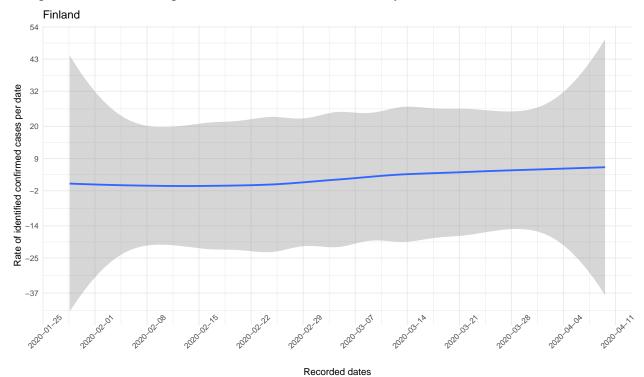




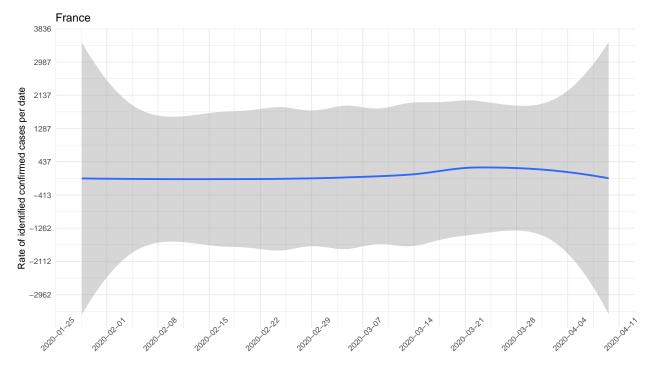


Recorded dates

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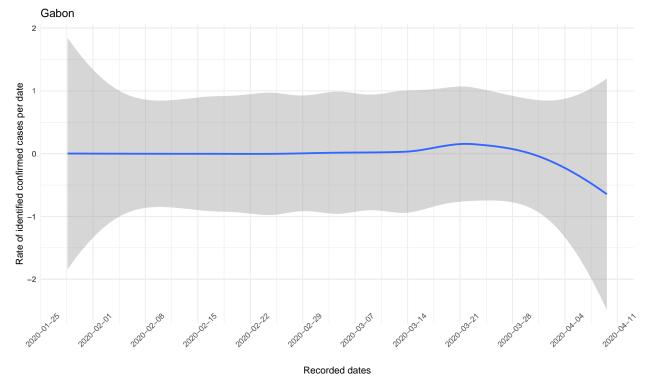


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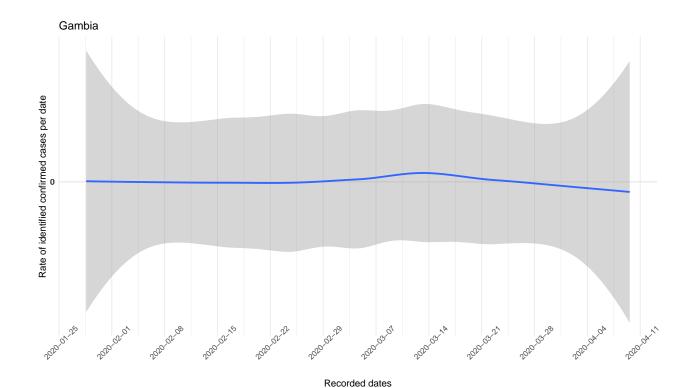


Recorded dates

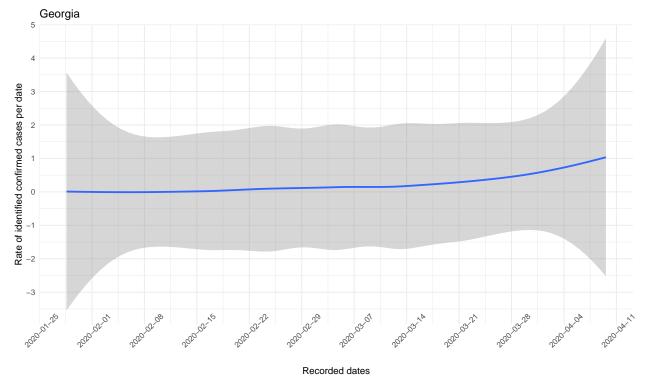
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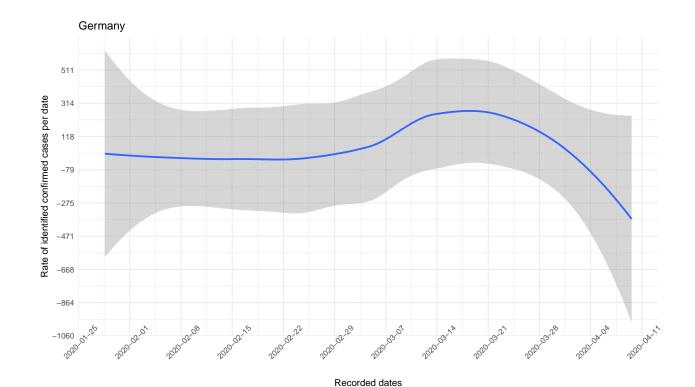
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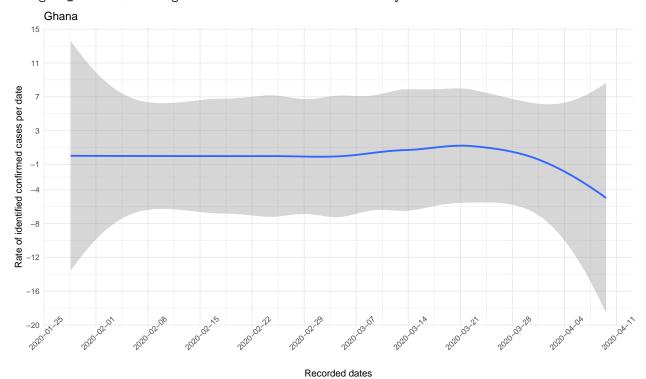
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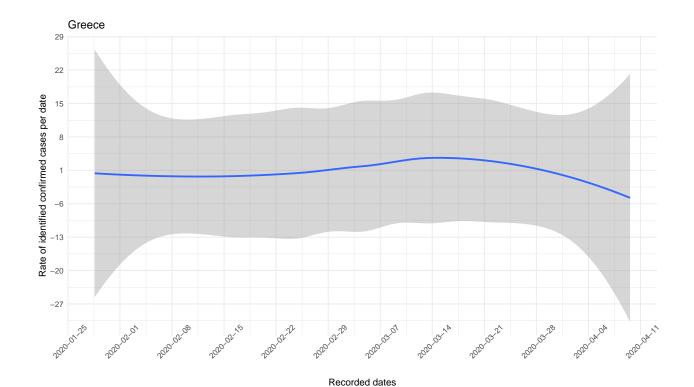
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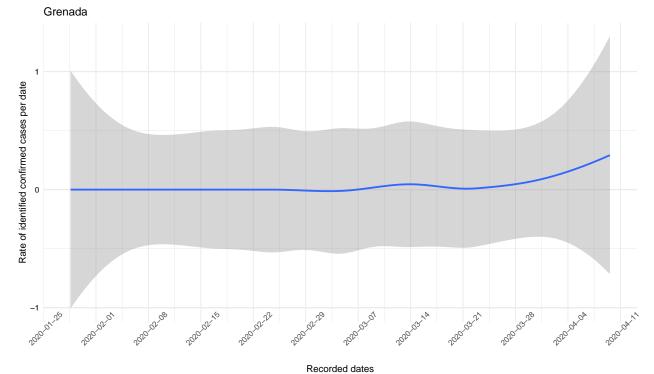
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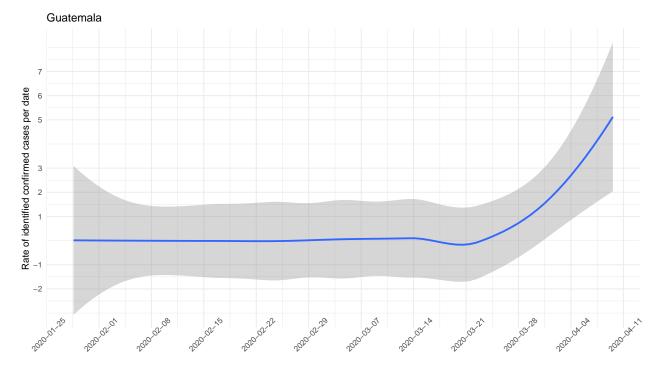
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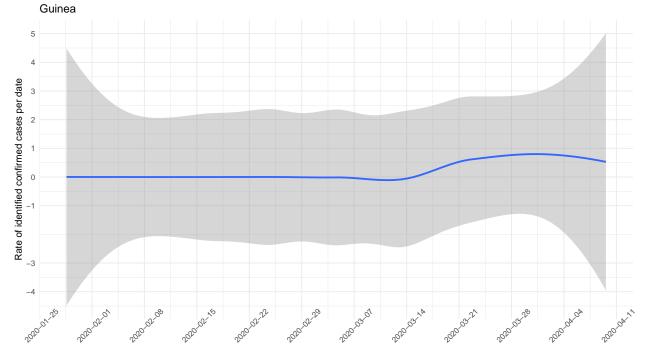
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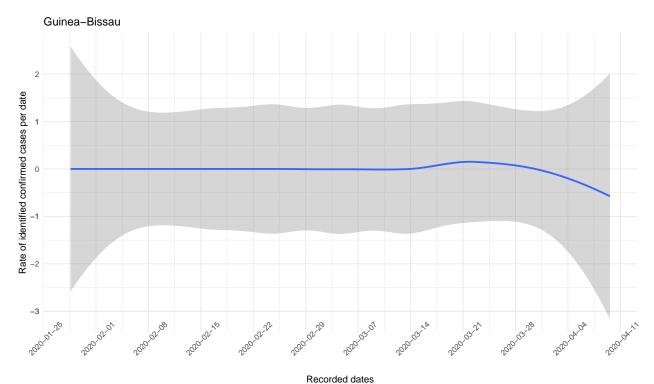
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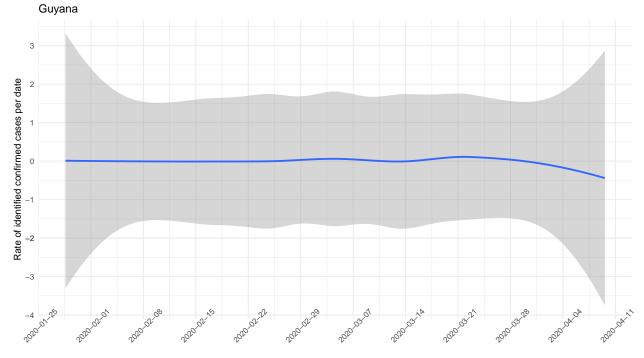
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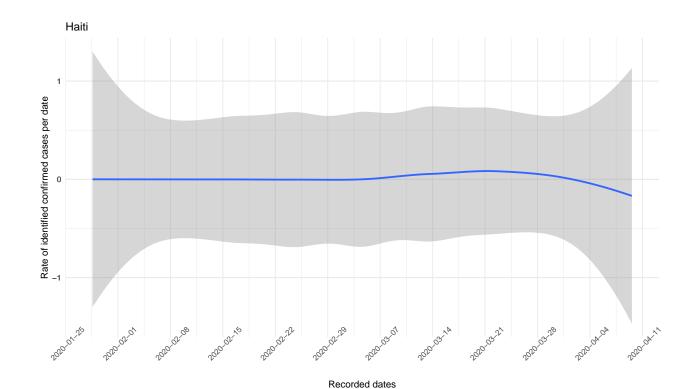
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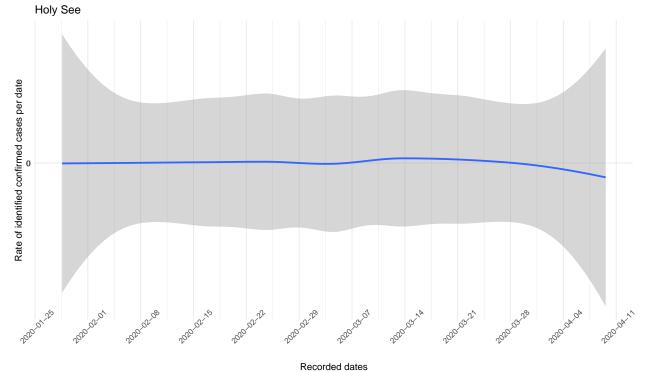


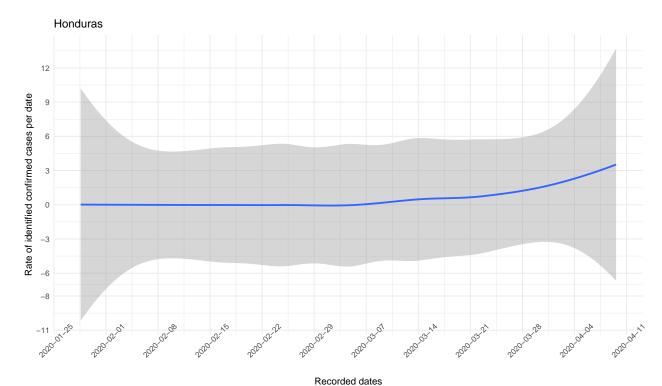
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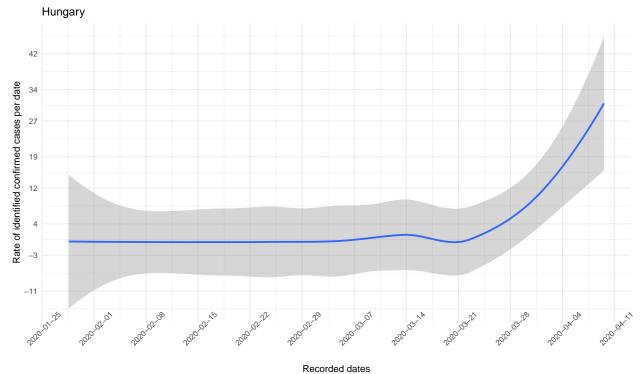
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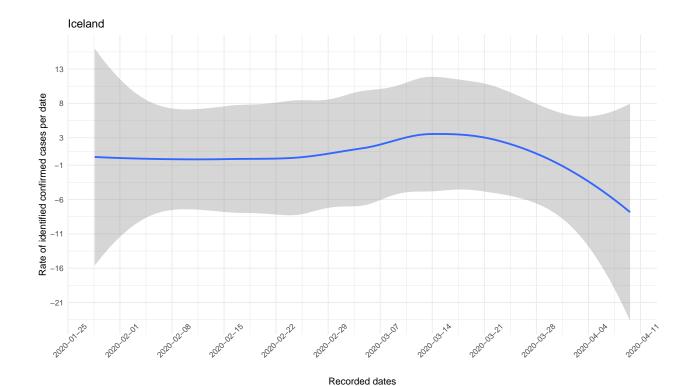




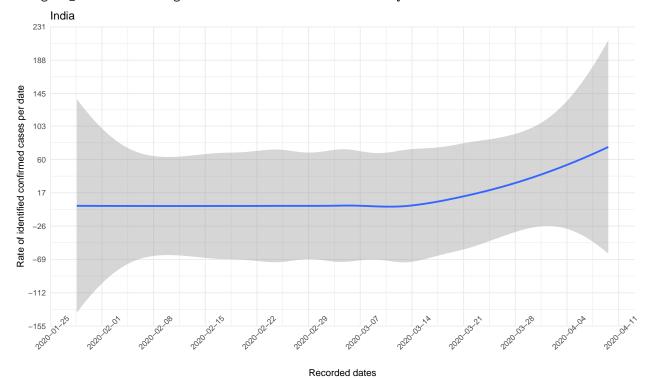
Necolded dates



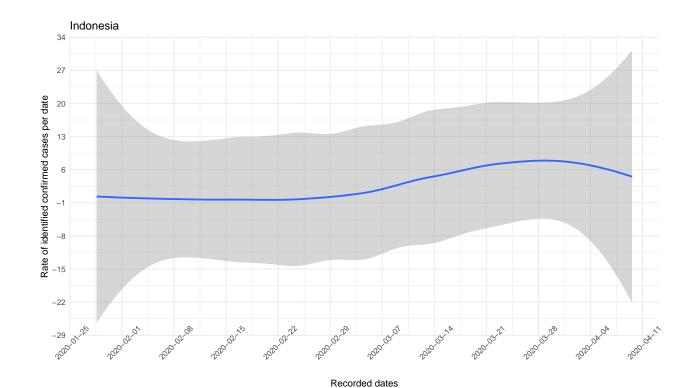
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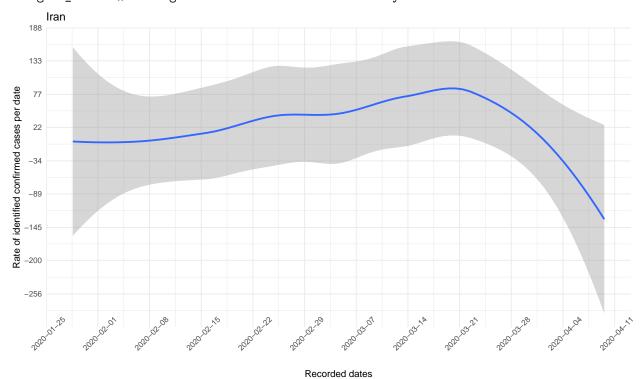
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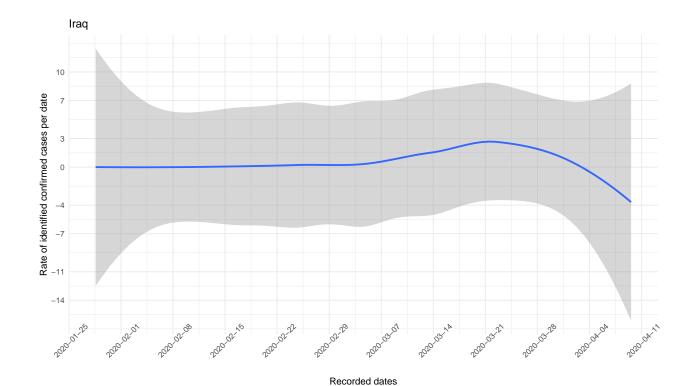
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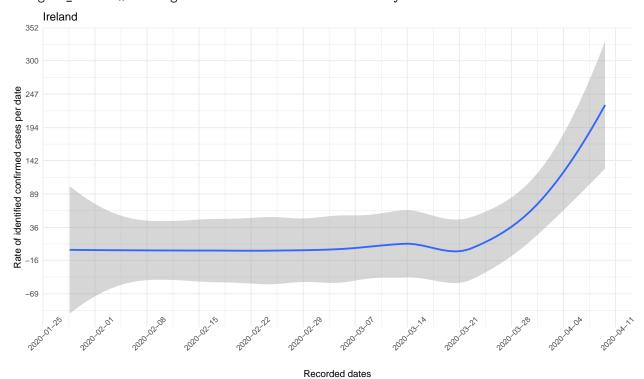
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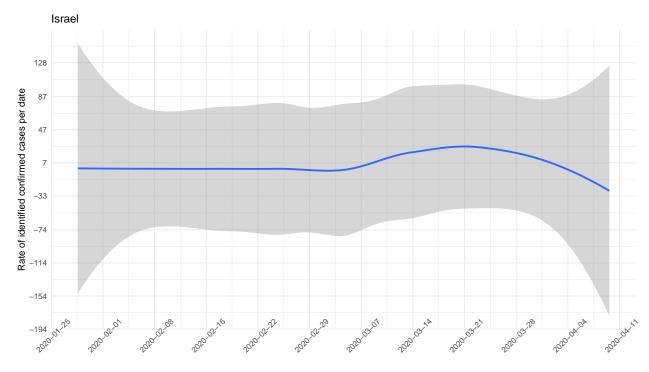
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$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

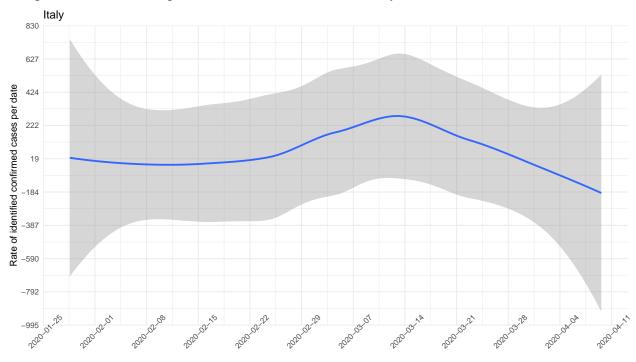


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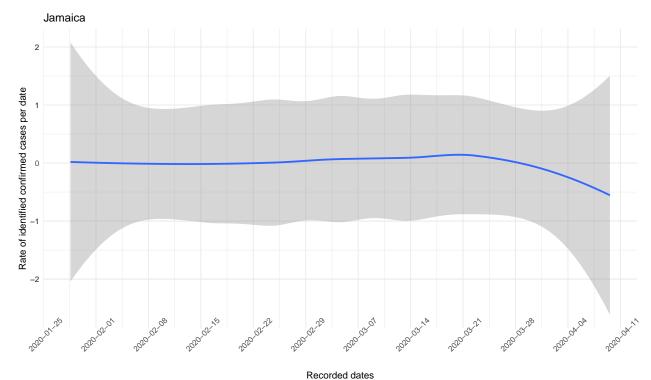
Recorded dates

$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

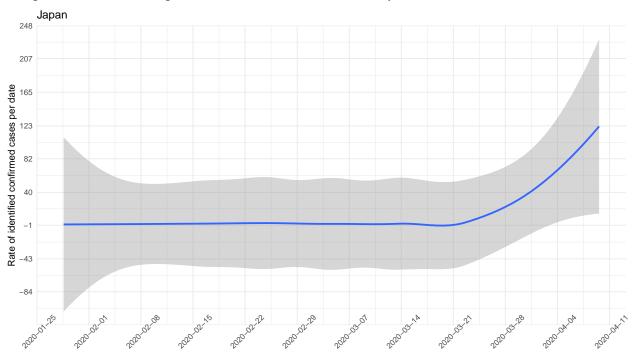


Recorded dates

$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

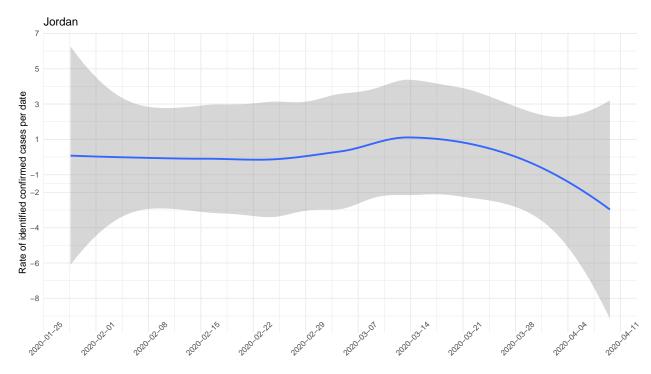


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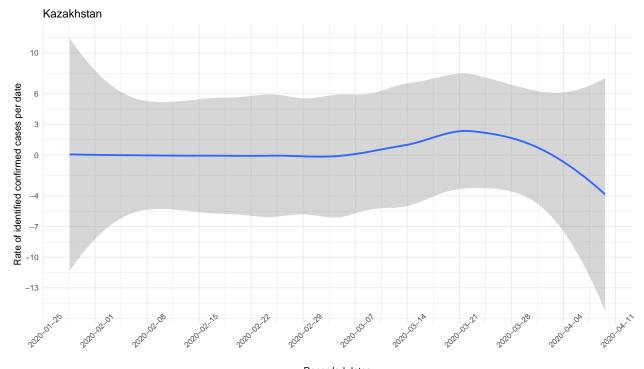
Recorded dates

$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



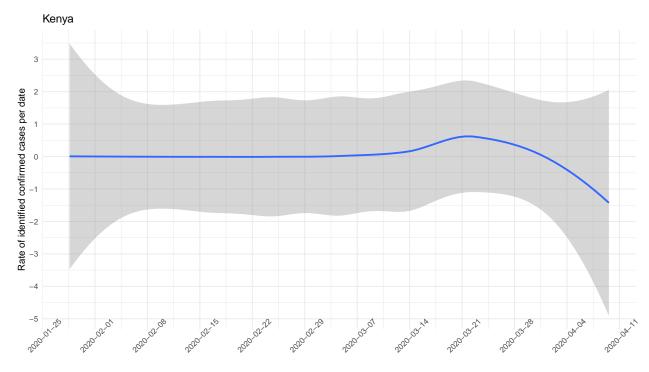
Recorded dates

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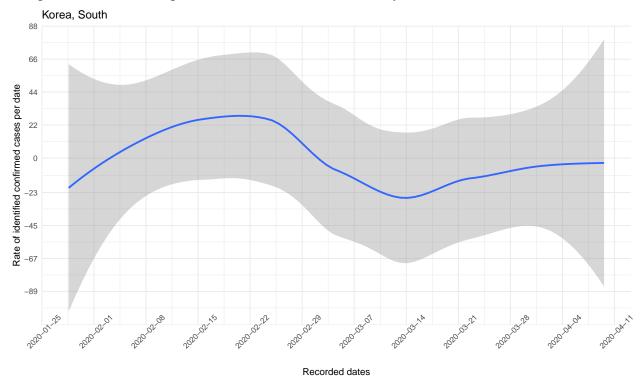
Recorded dates

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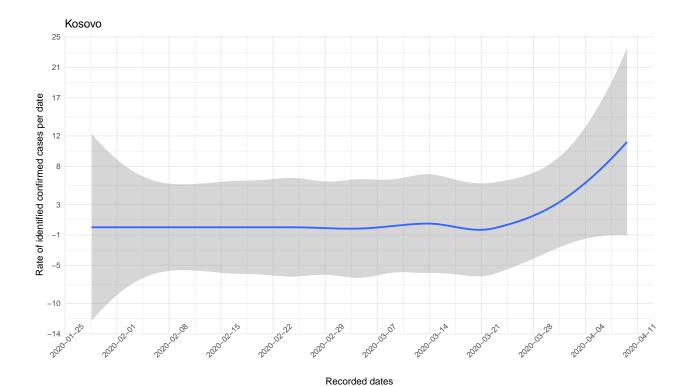


Recorded dates

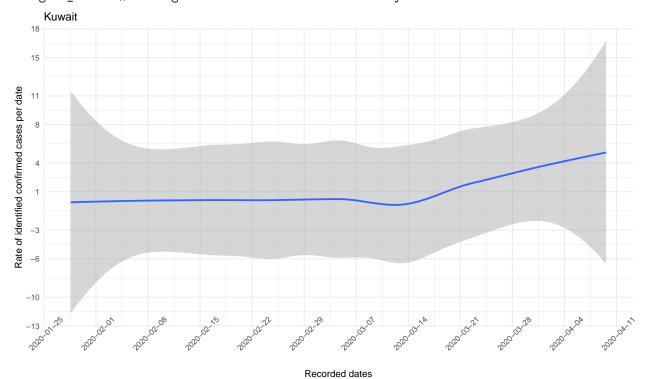
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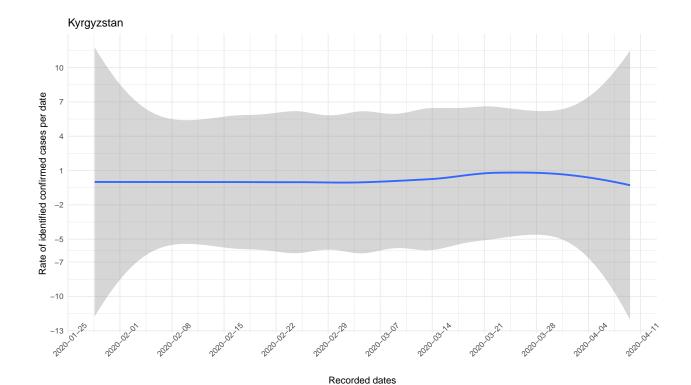
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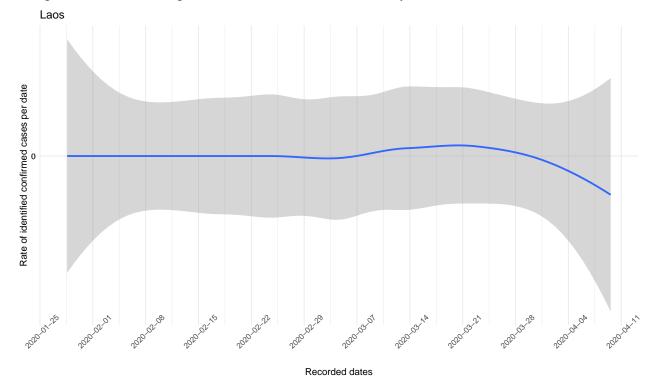
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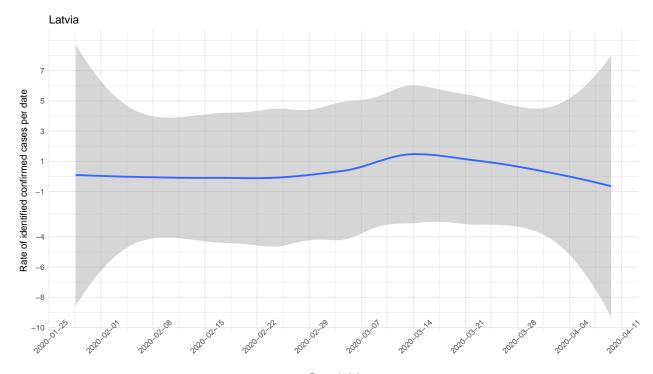
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$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

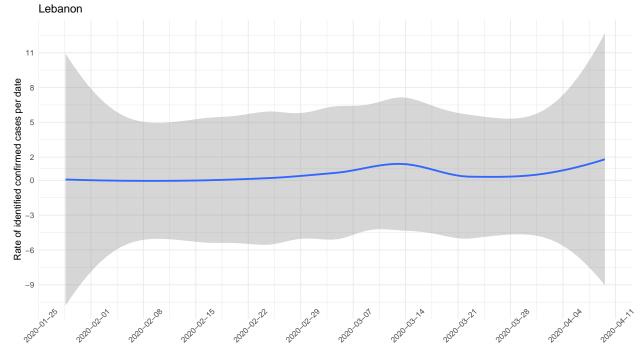


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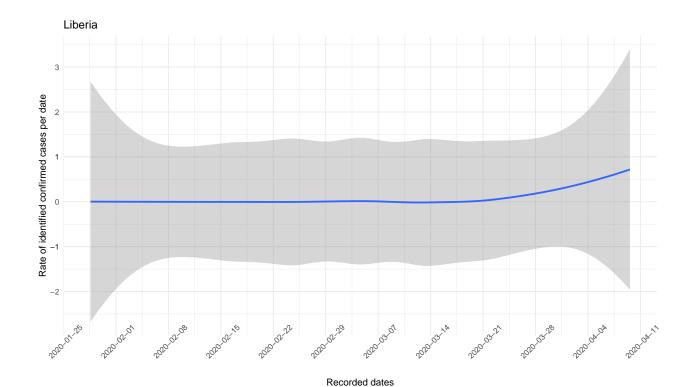
Recorded dates

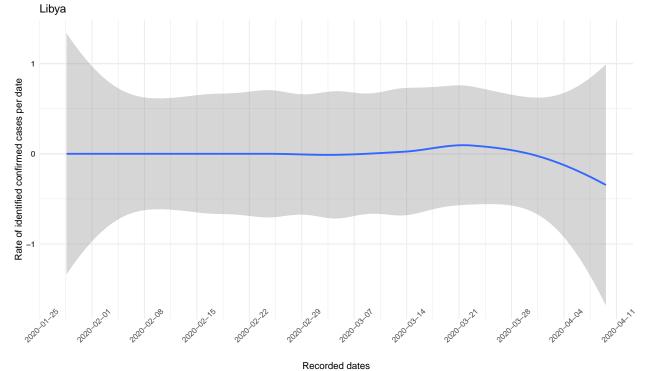
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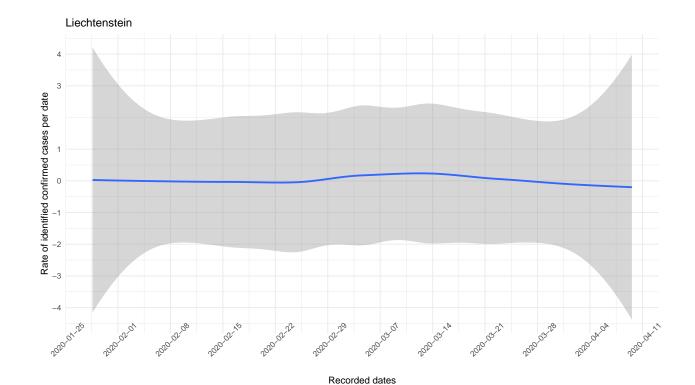


Recorded dates

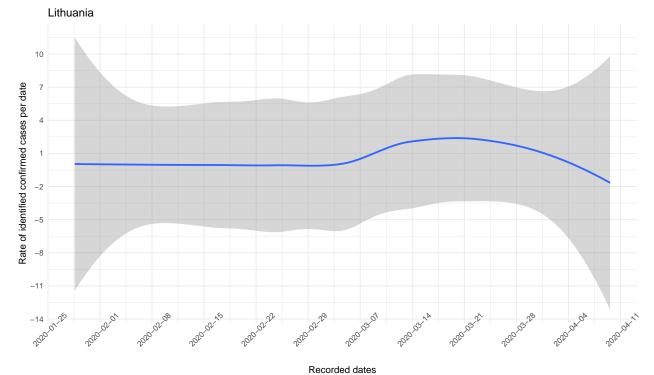
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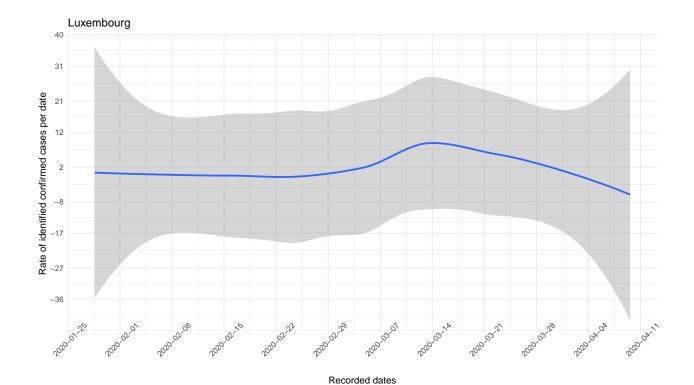




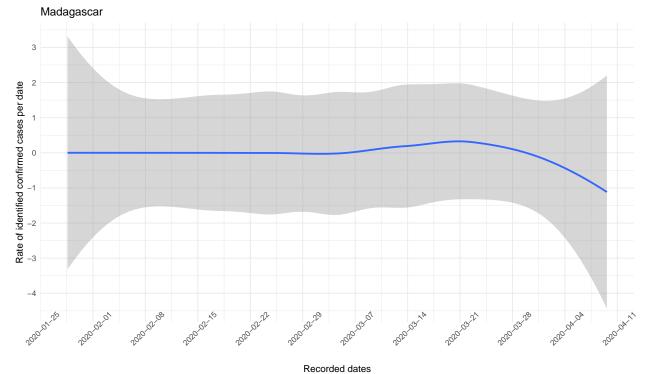
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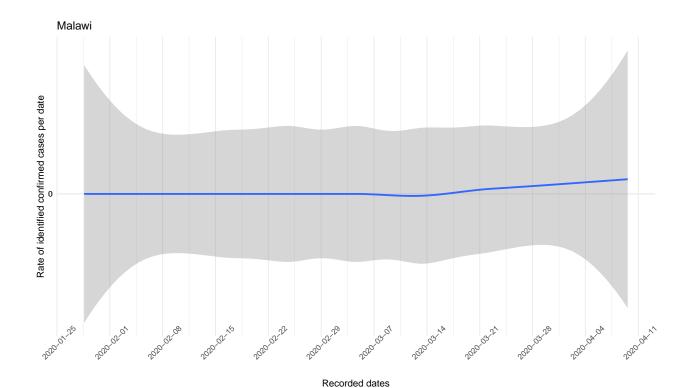
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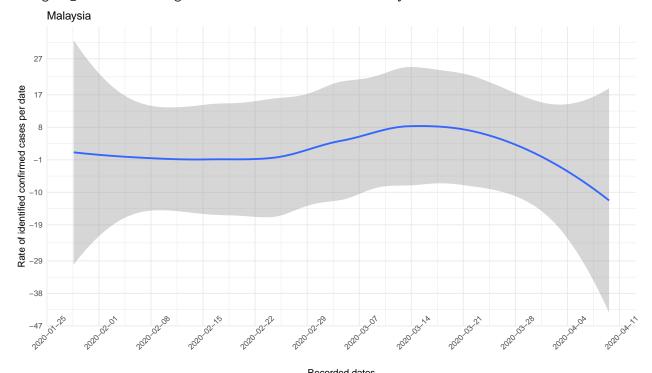
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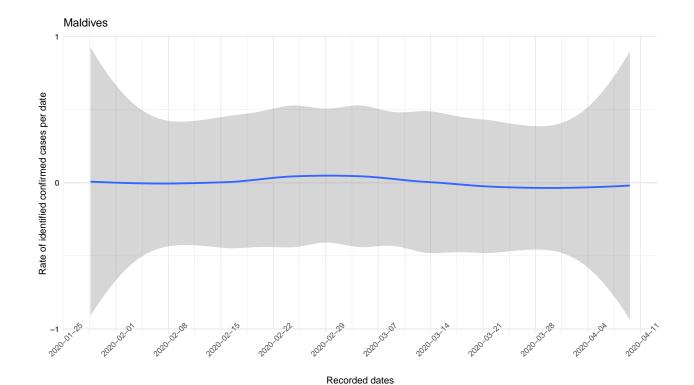
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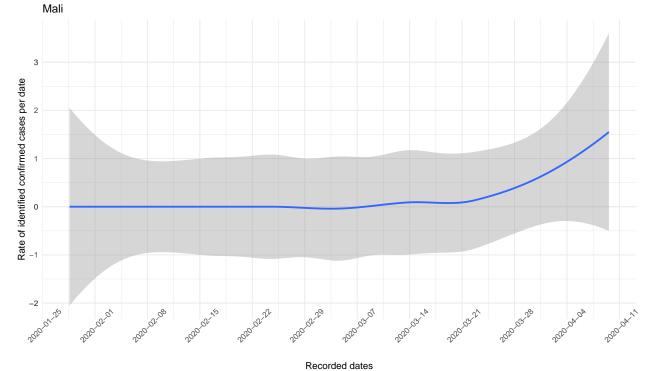
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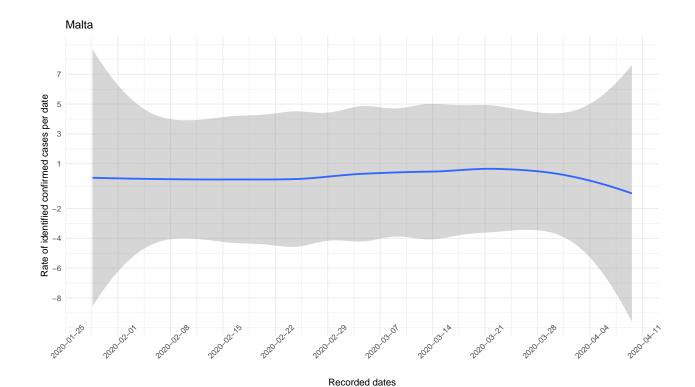
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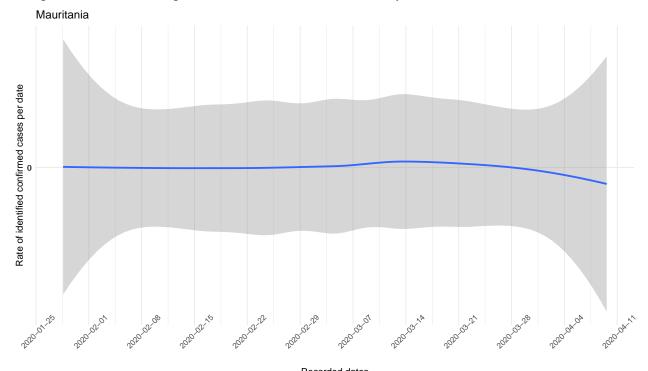
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



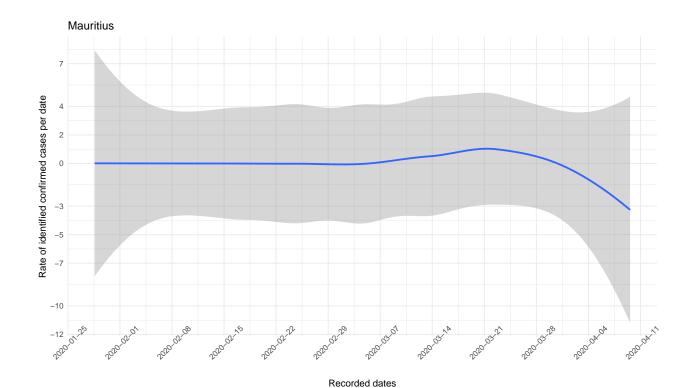
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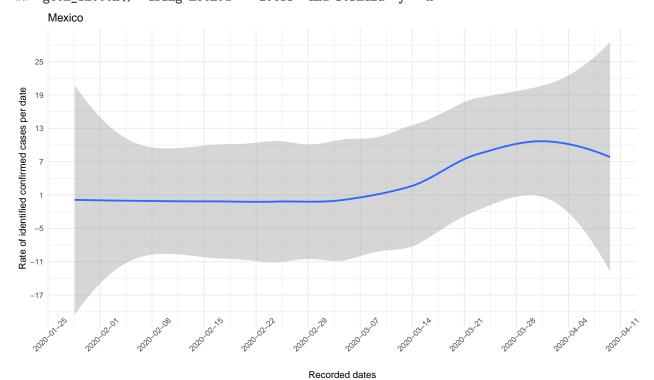
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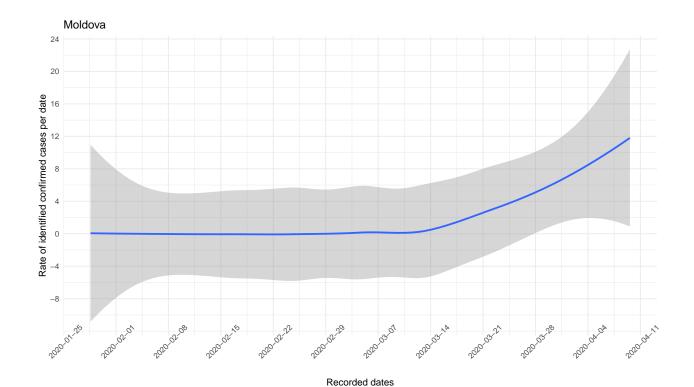
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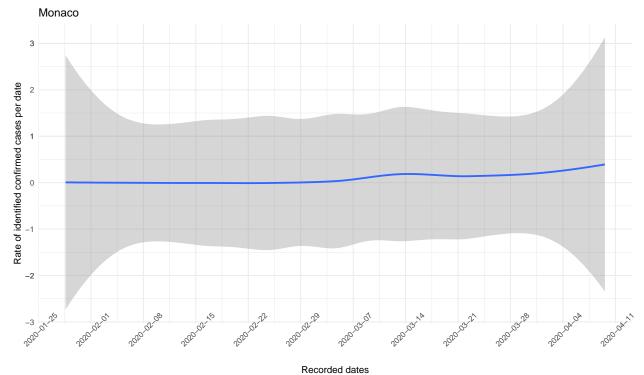
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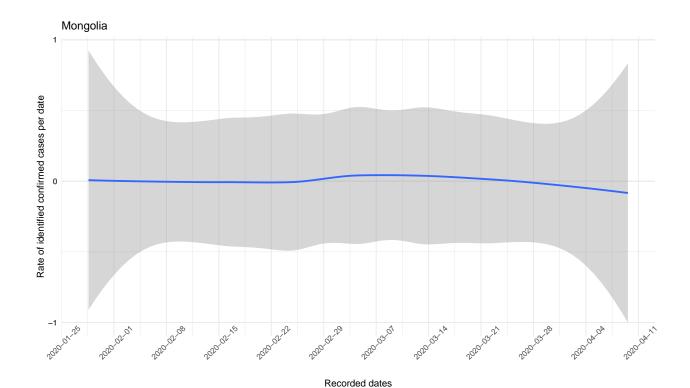
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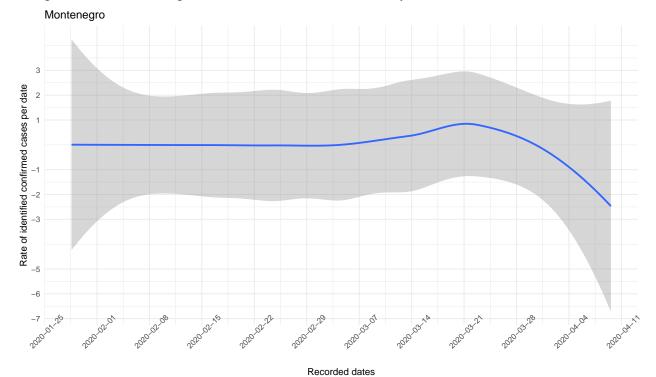
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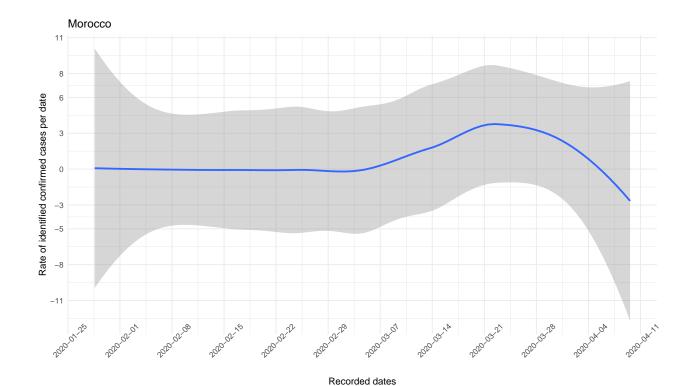
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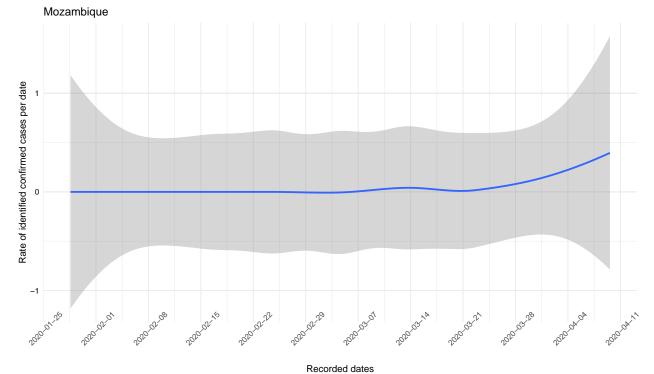


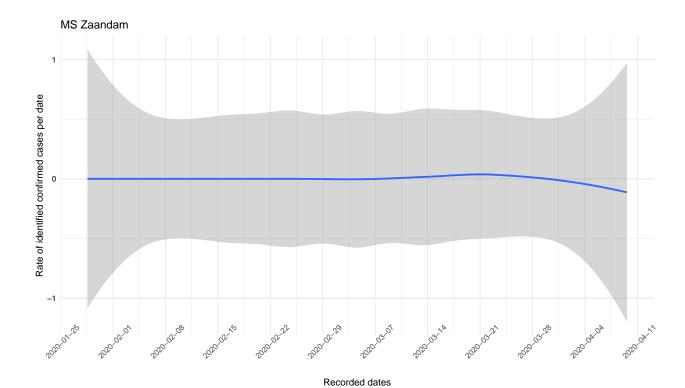
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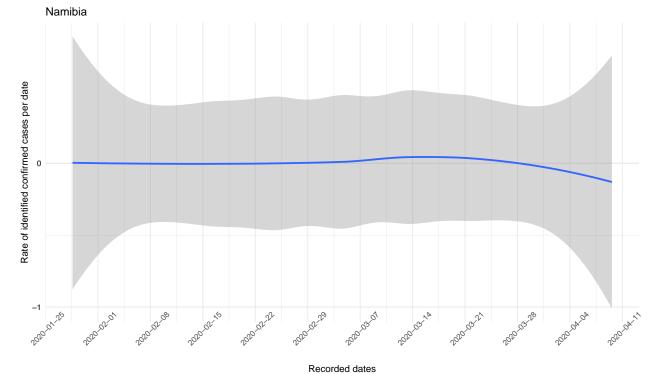


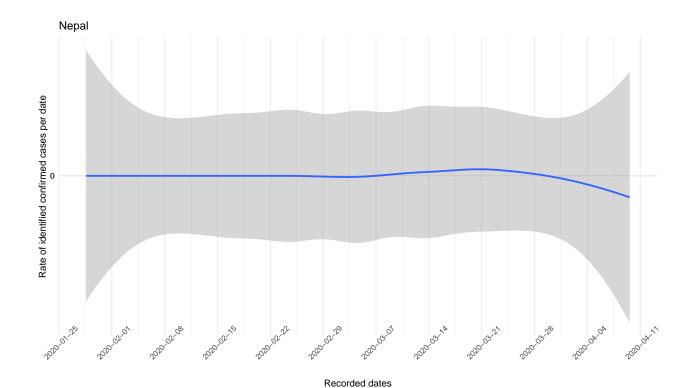
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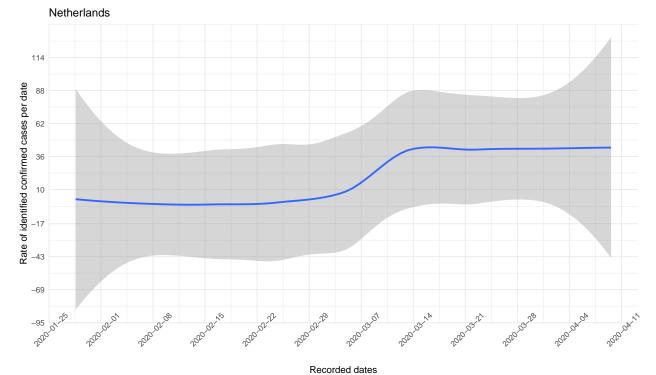




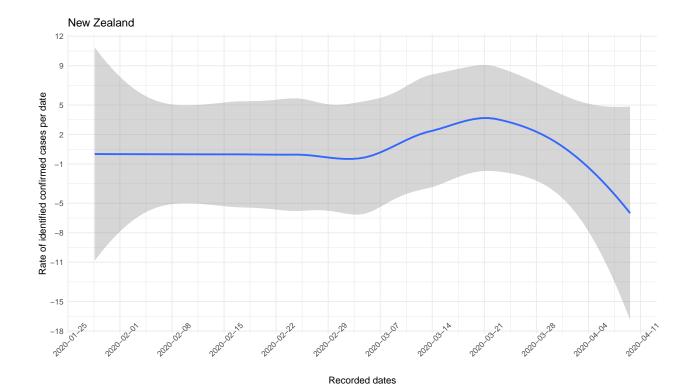




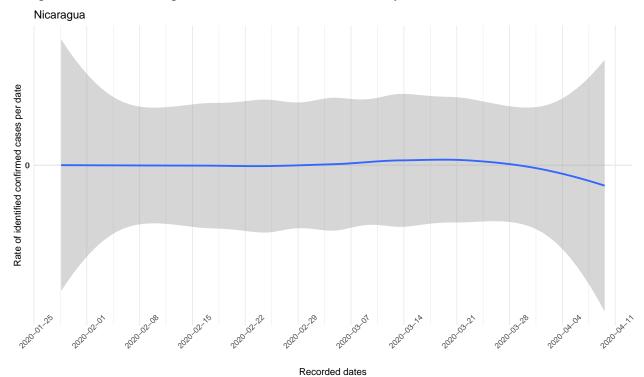
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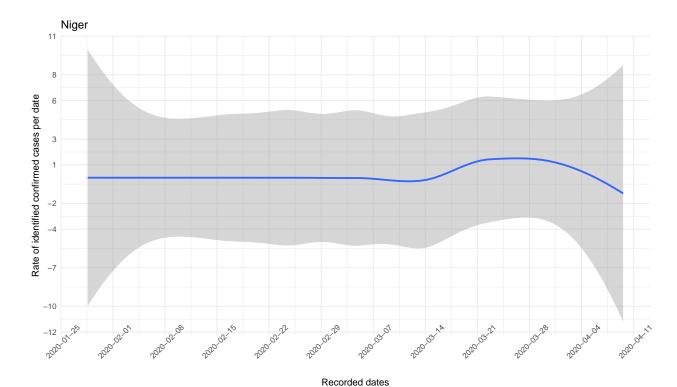
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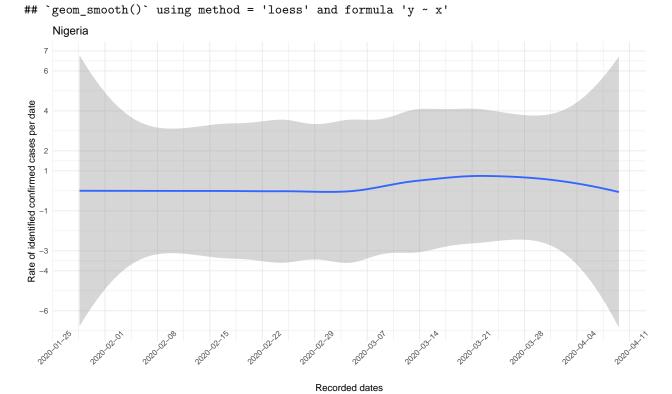


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

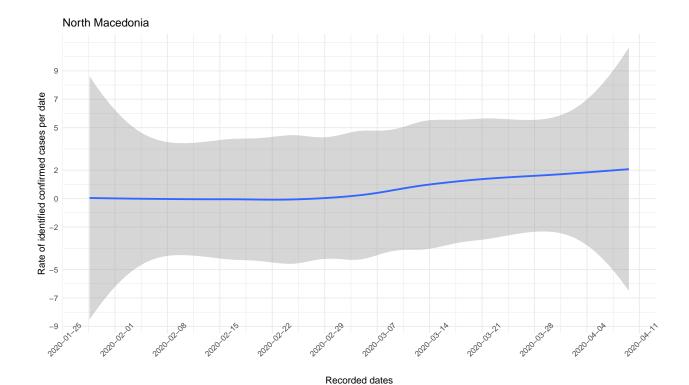


$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

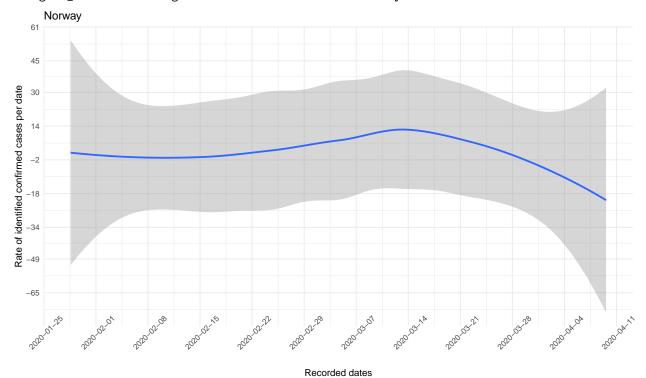




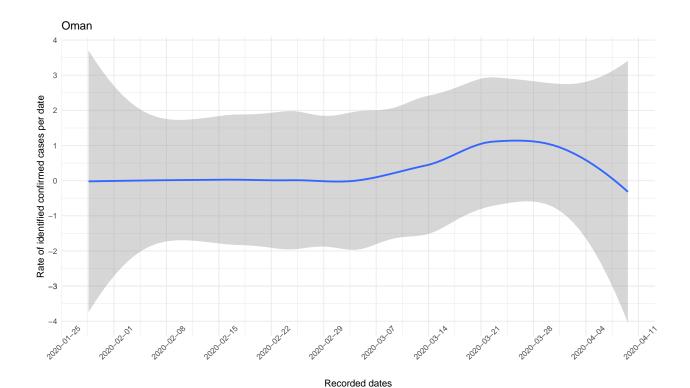
$geom_smooth()$ using method = 'loess' and formula 'y ~ x'



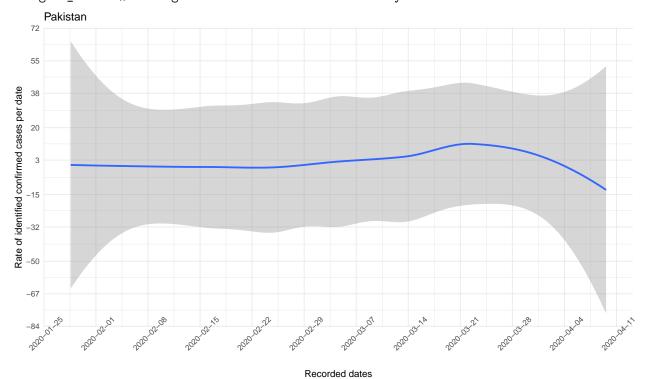
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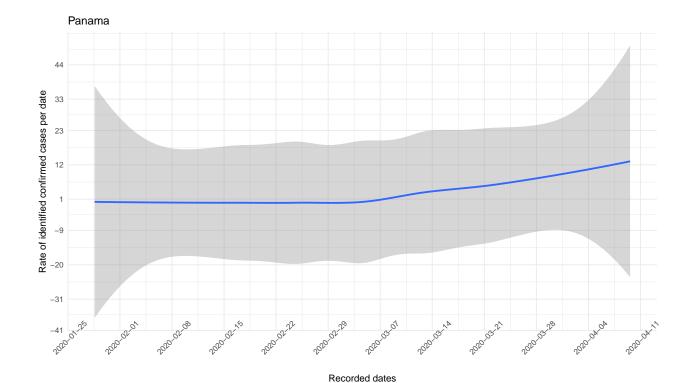
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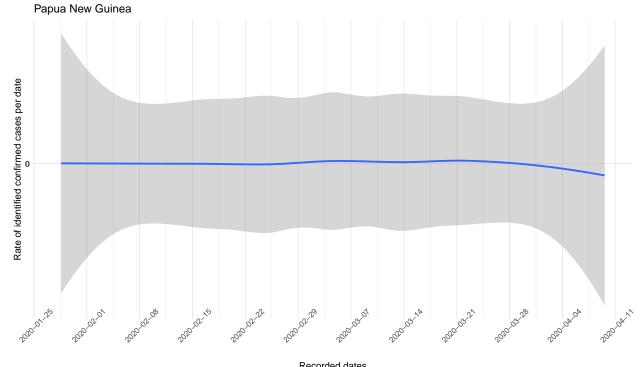
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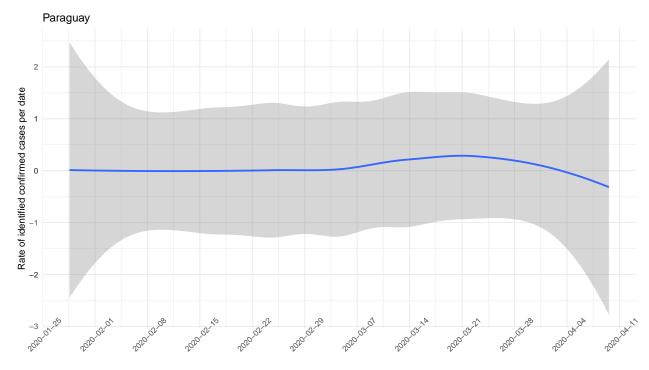
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$geom_smooth()$ using method = 'loess' and formula 'y ~ x'

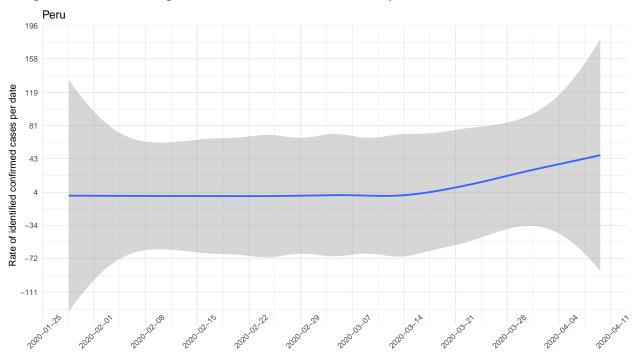


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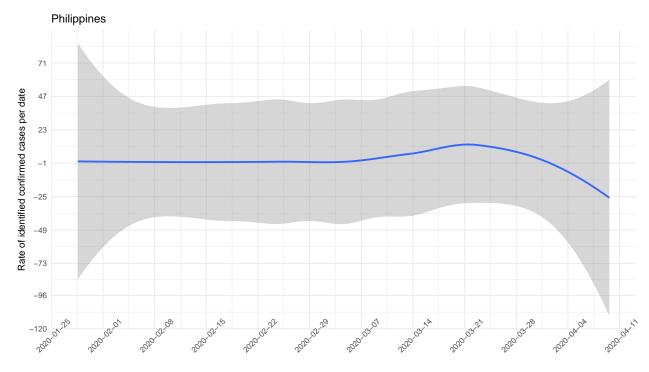


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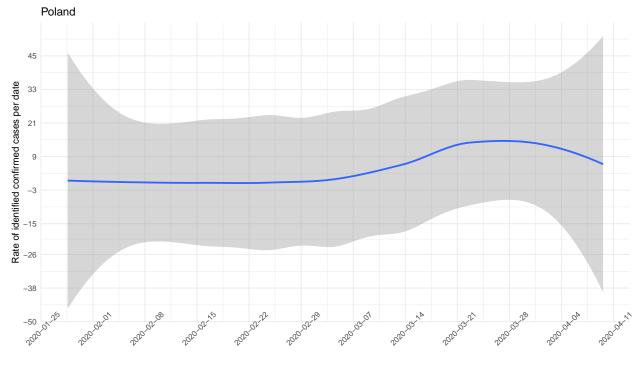


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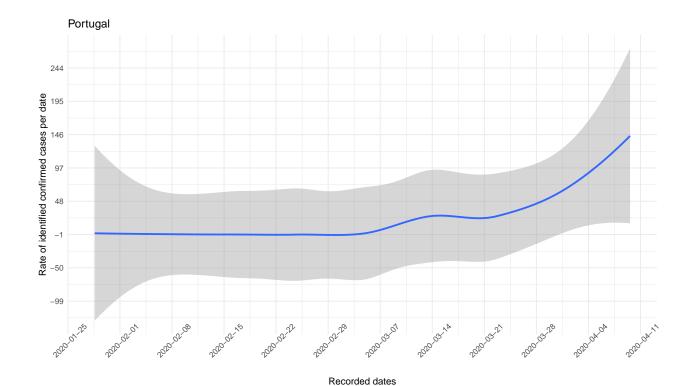


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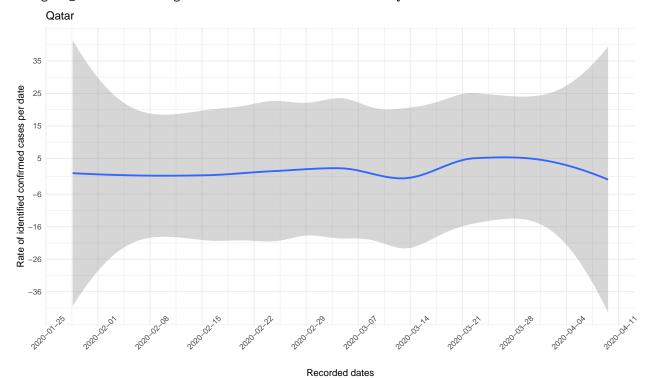
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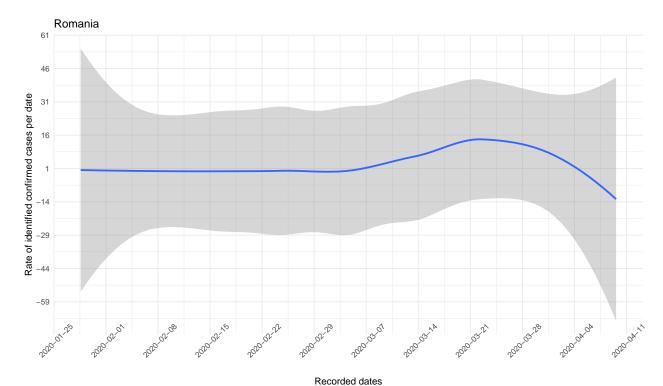
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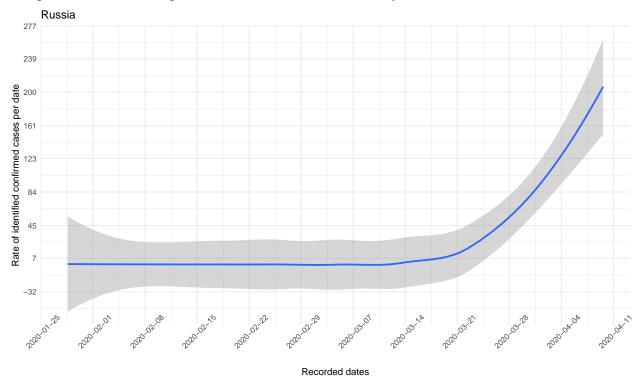
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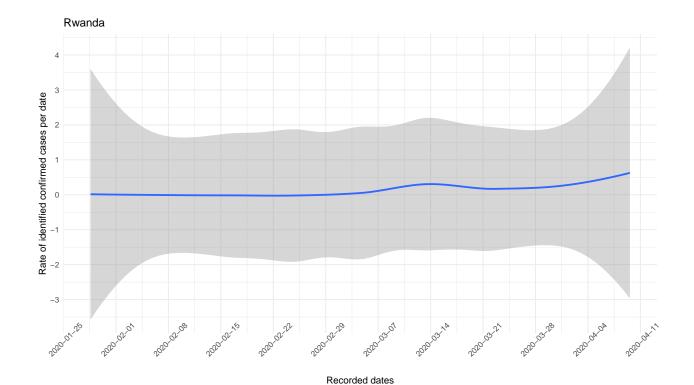
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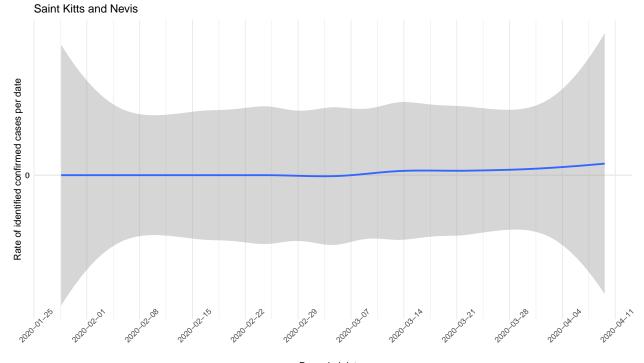
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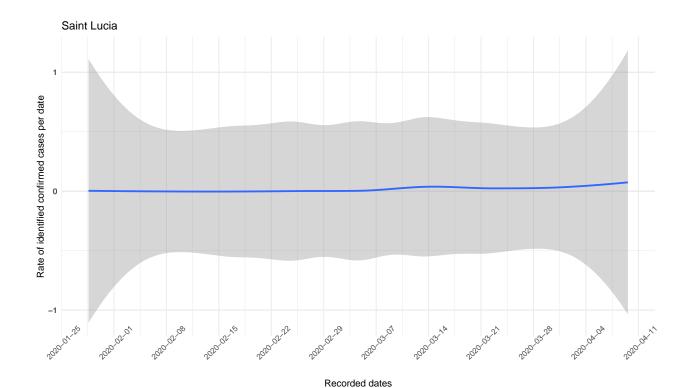
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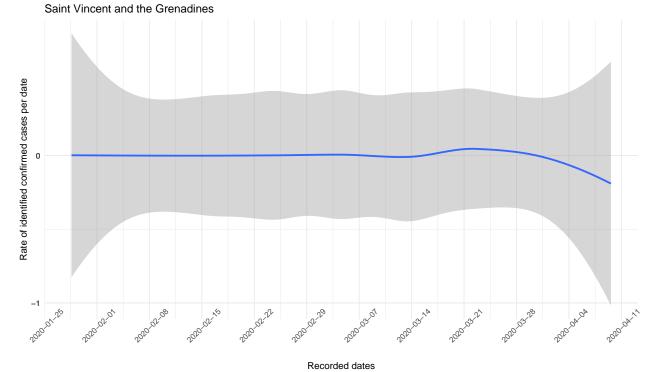
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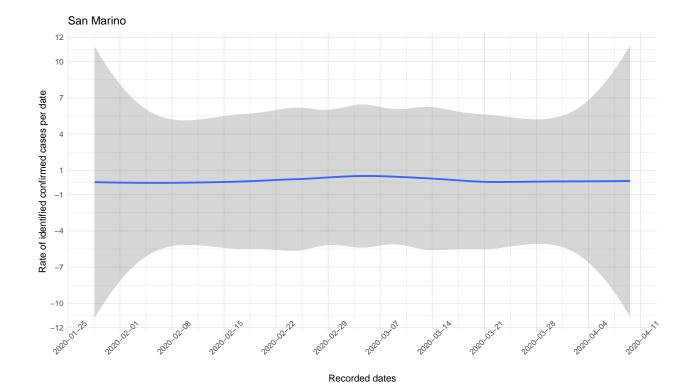
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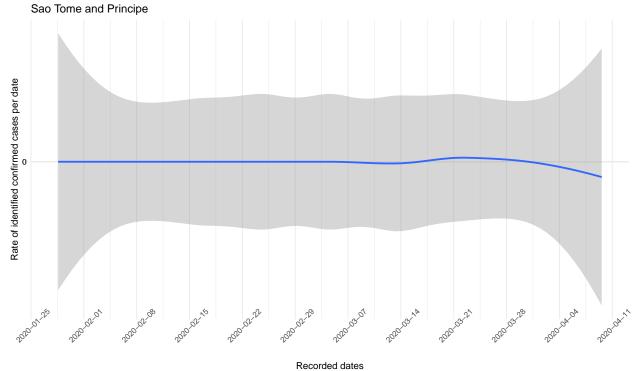
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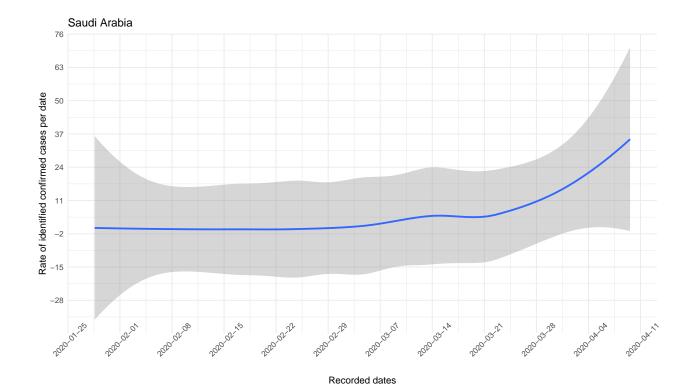
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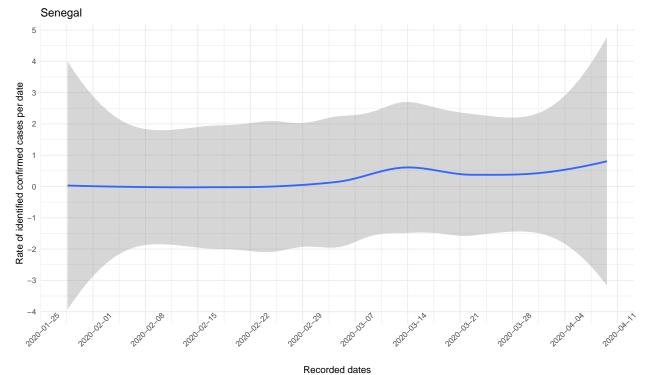
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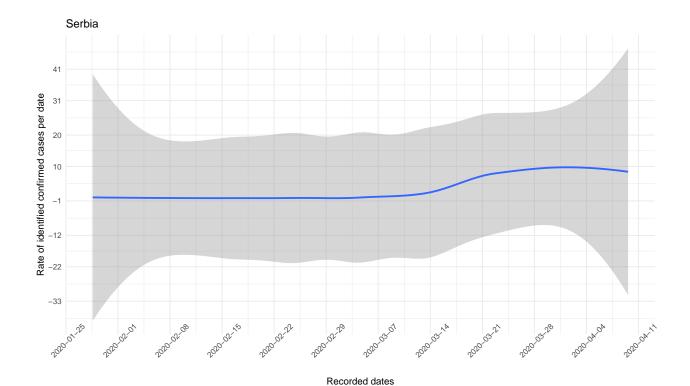
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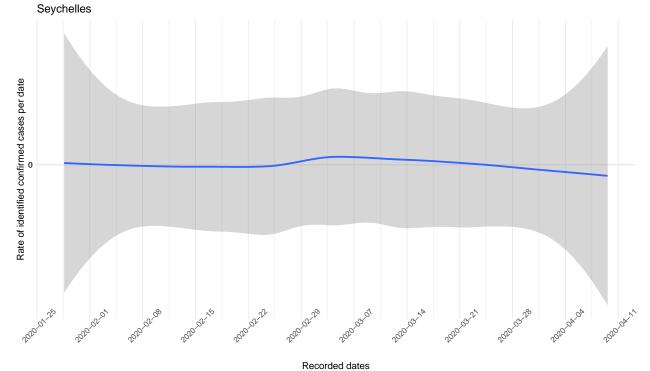


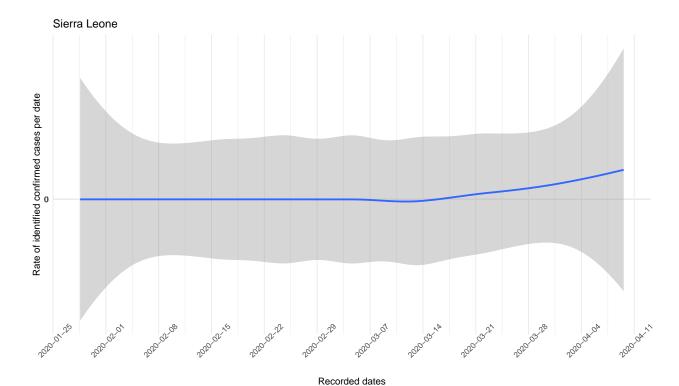
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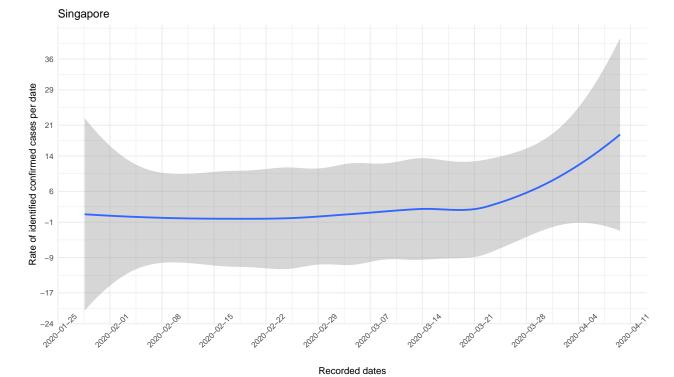
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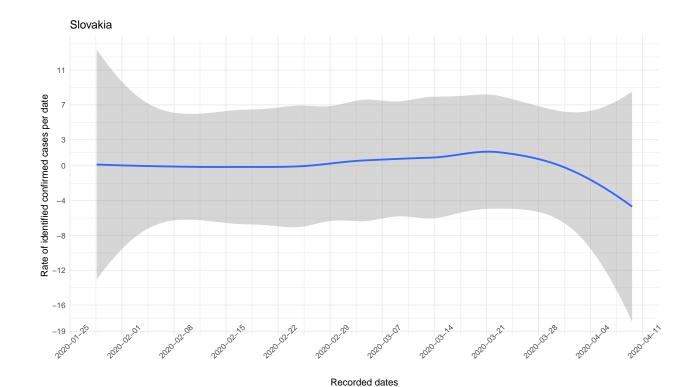




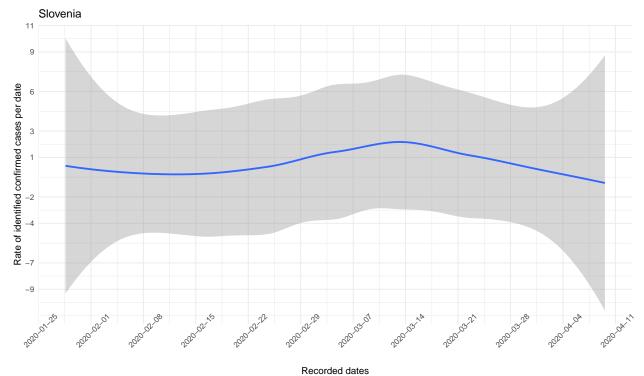
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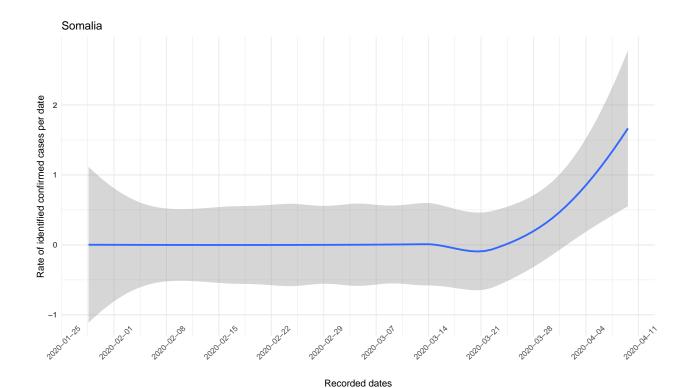
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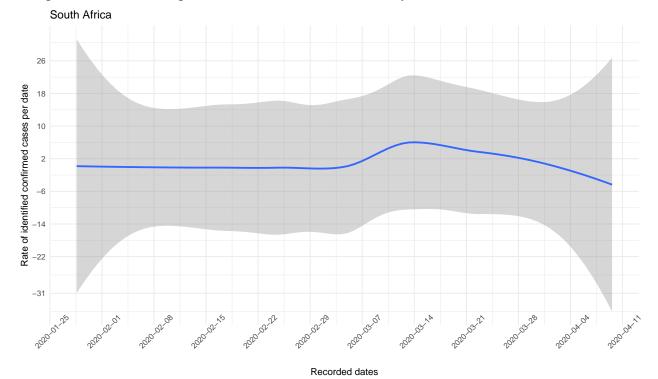
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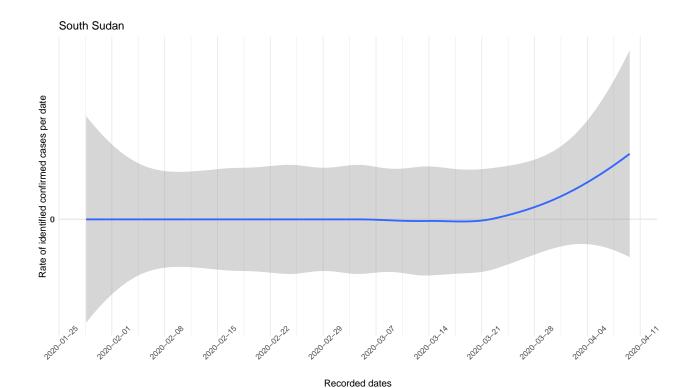
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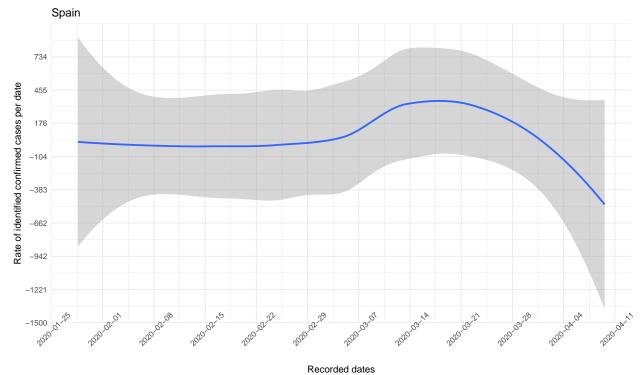
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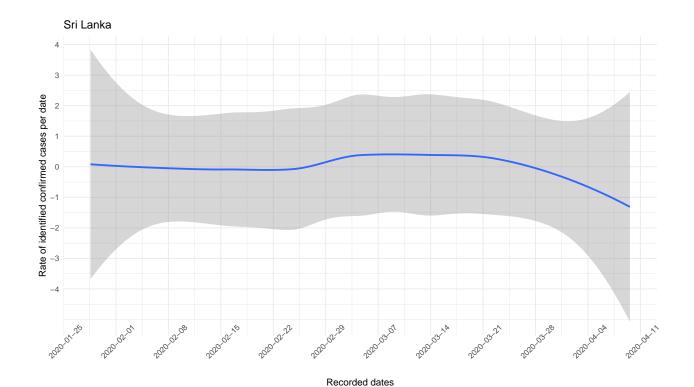
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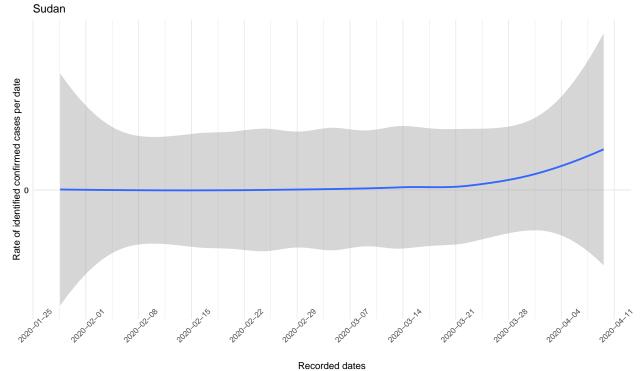
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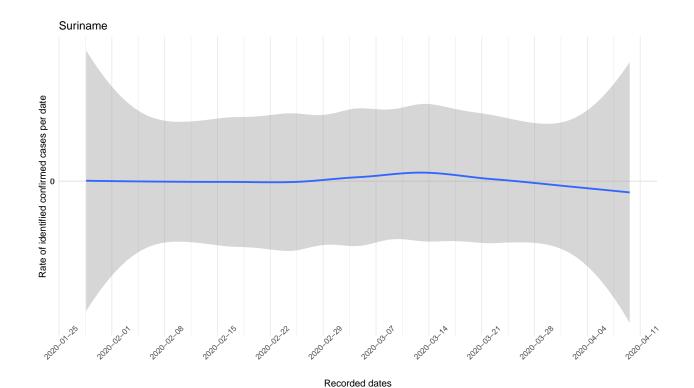
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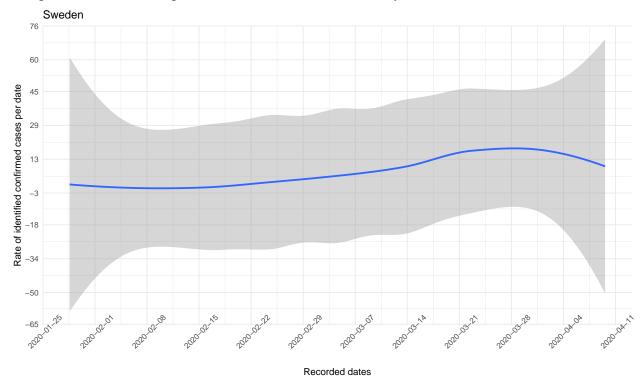
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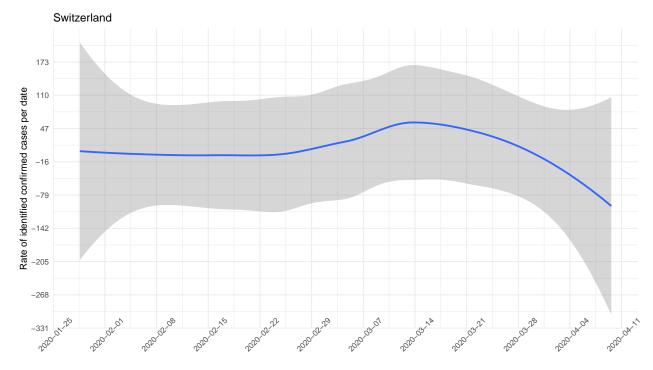
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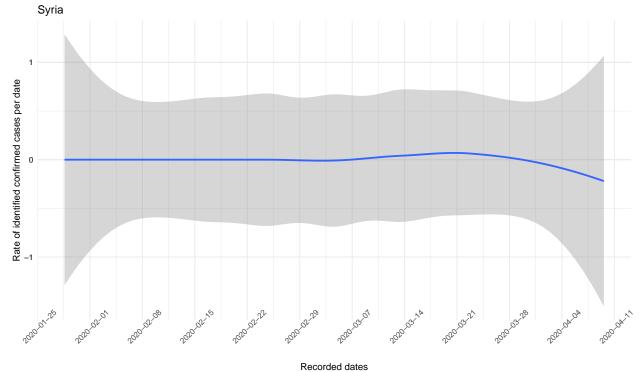


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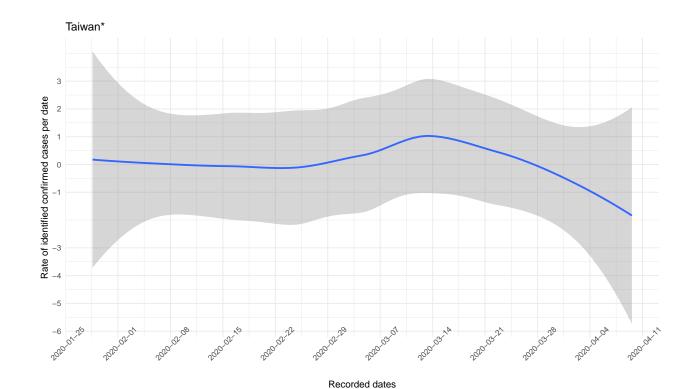


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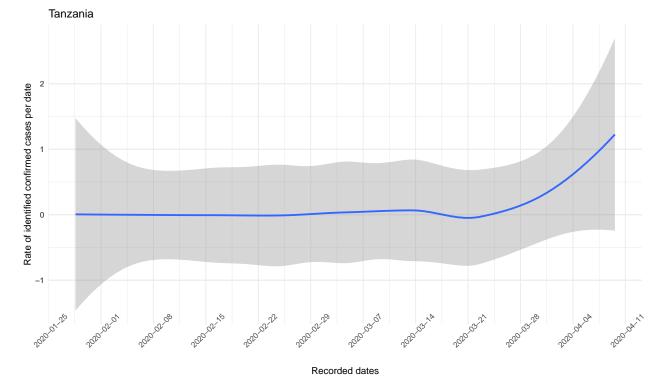
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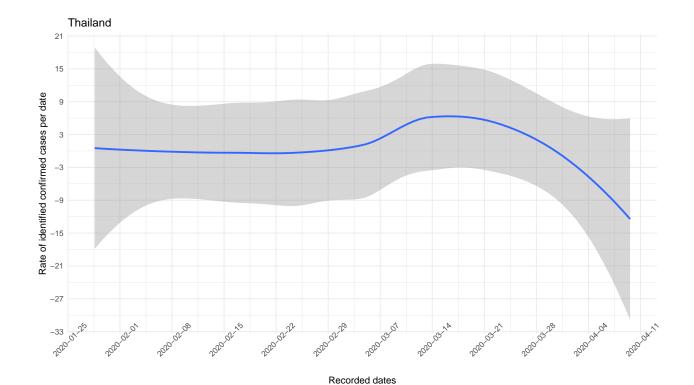
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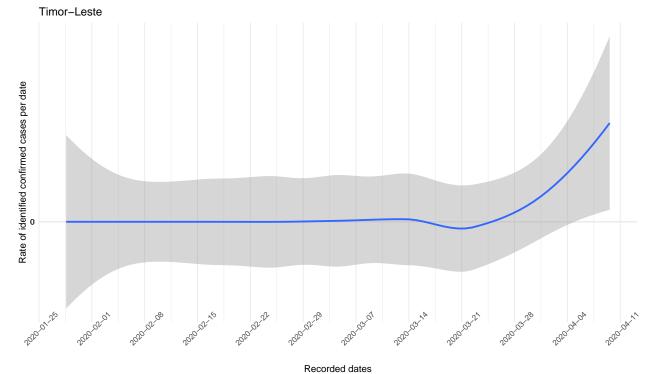
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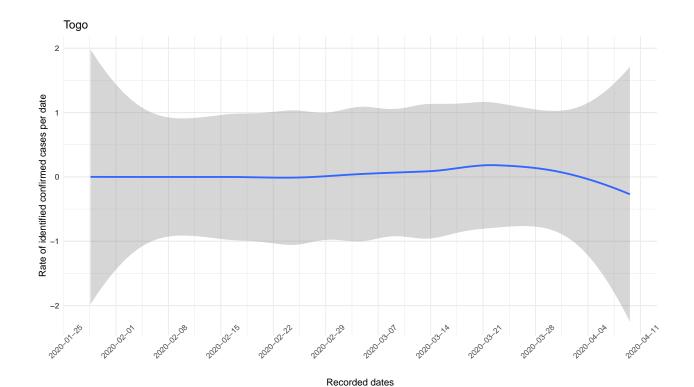
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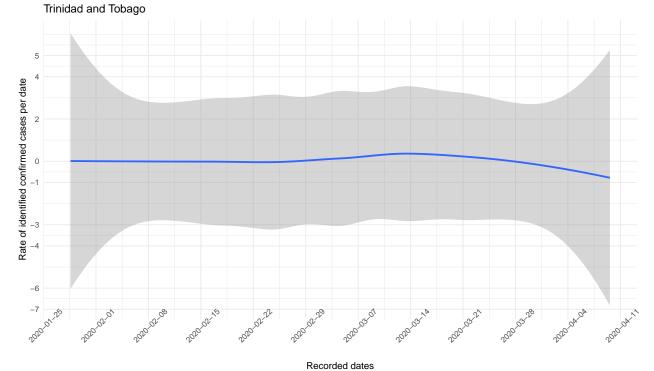
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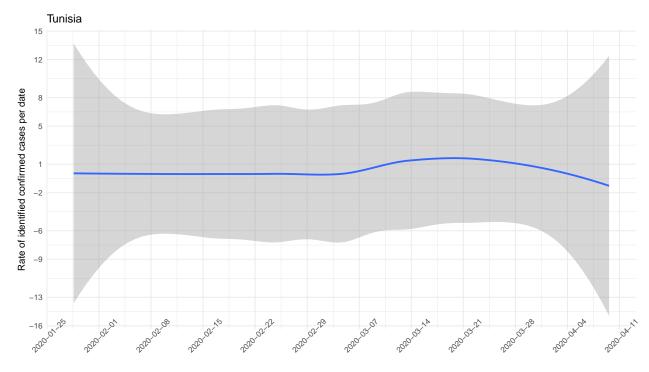
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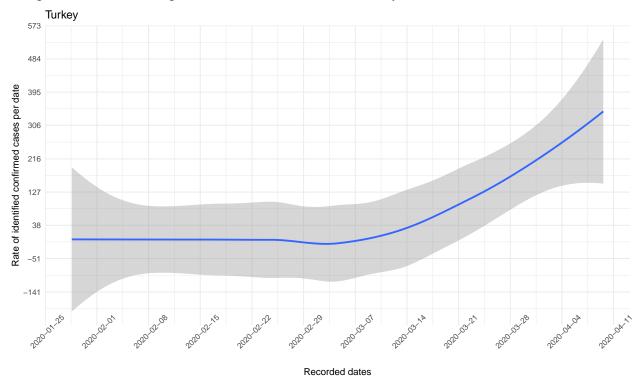


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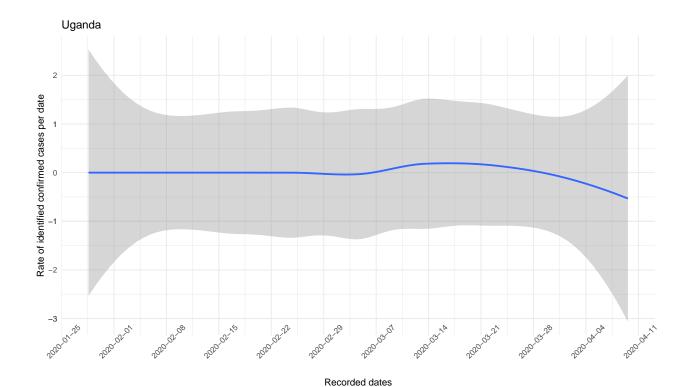


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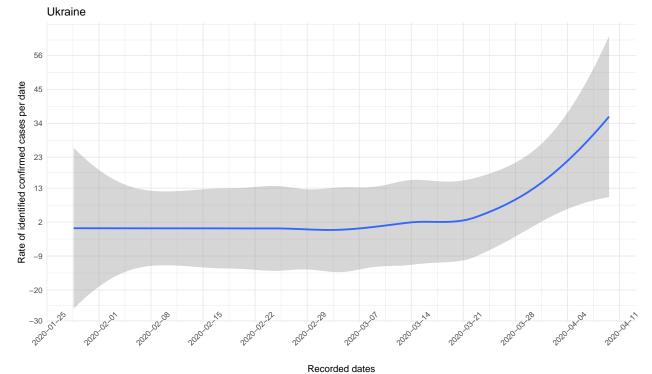
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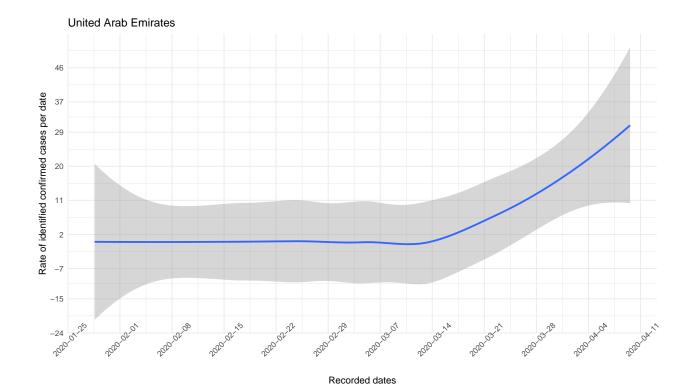
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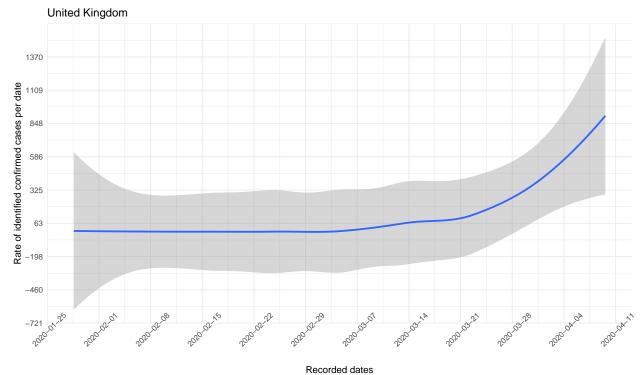
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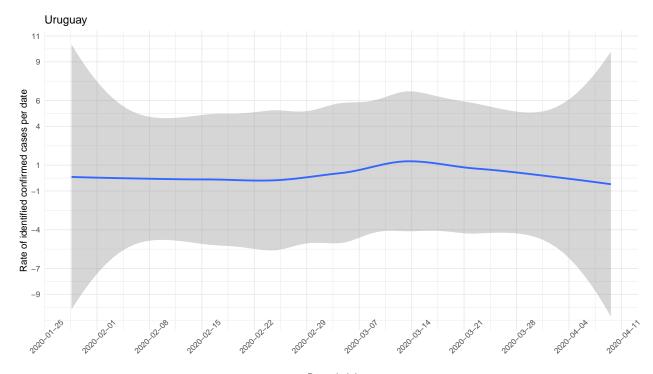
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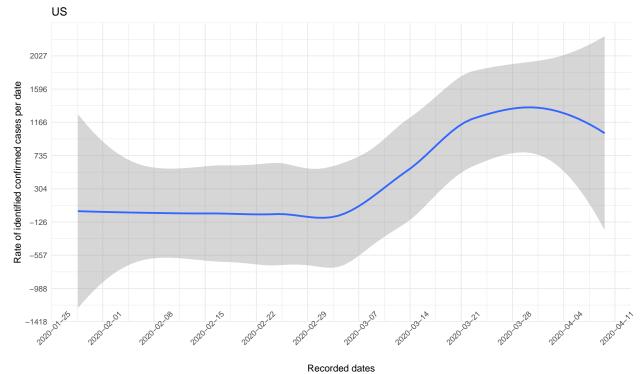


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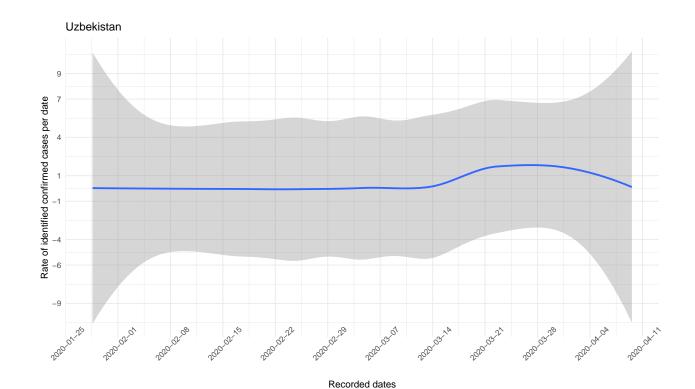


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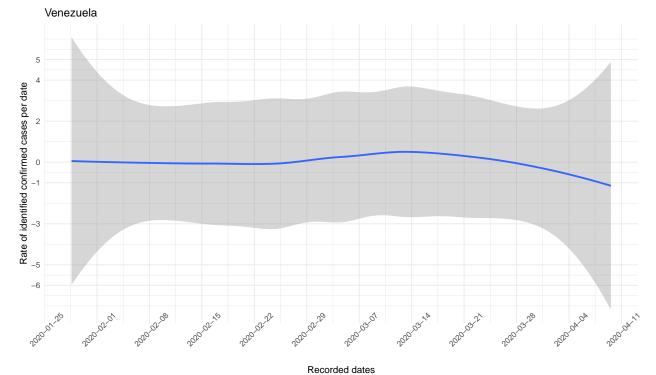
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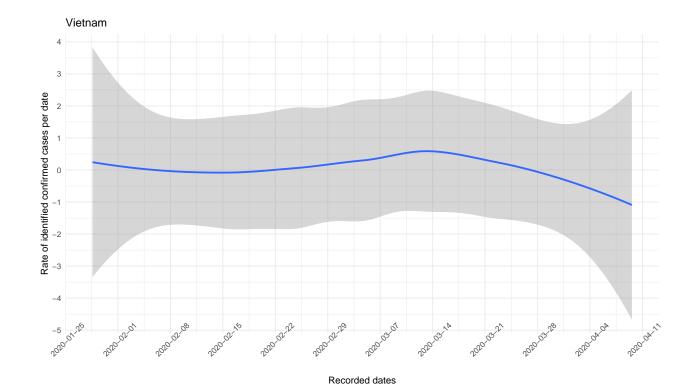
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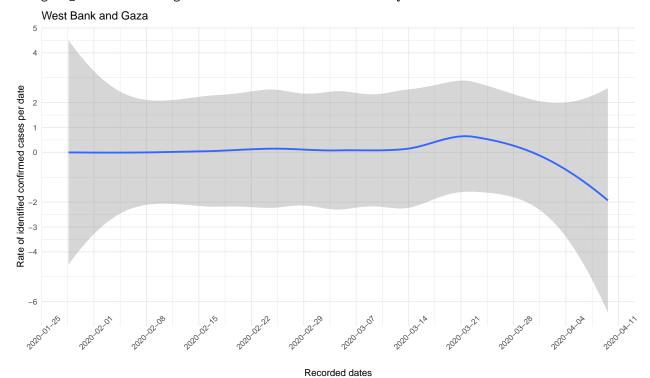
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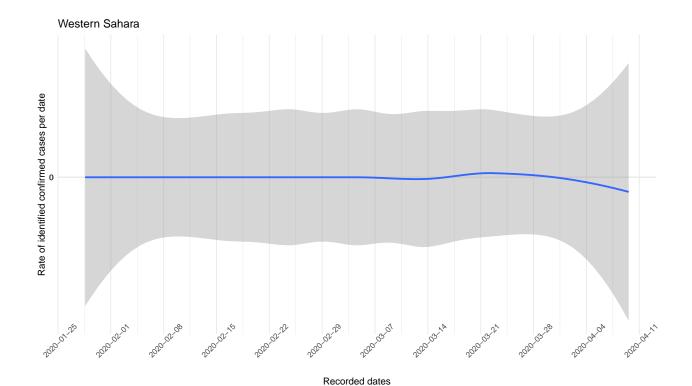
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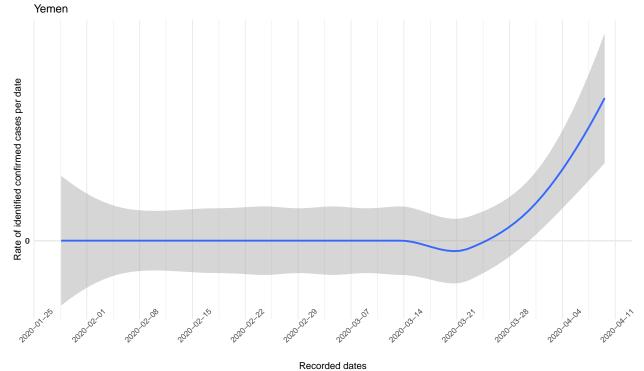
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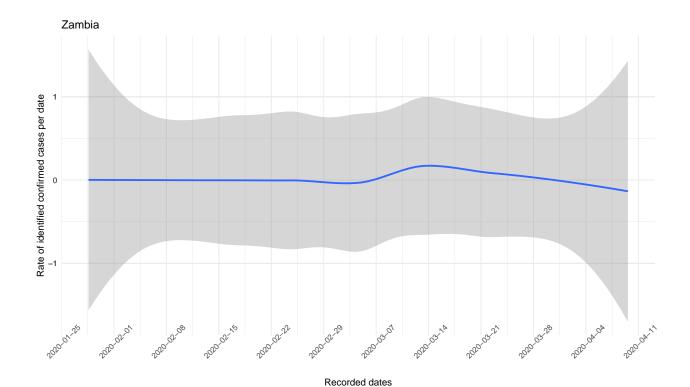
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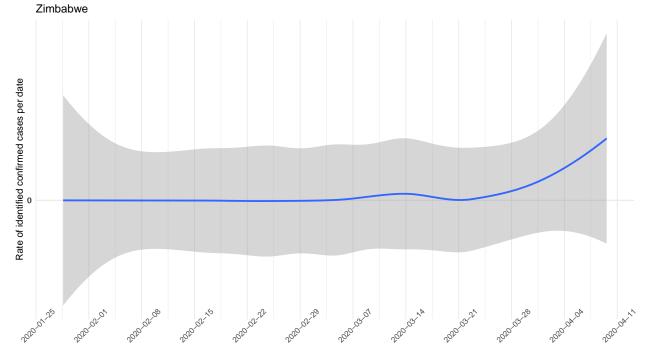
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