# CODECHECK certificate 2020-011

https://doi.org/10.5281/zenodo.3893138


| Item | Value |
|---|---|
| Title | Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe |
| Authors | Seth Flaxman, Imperial College COVID-19 Response Team, Samir Bhatt |
| Reference | Nature, in press http://dx.doi.org/10.1038/s41586-020-2405-7 (2020) |
| Codechecker | Stephen J. Eglen |
| Date of check | 2020-06-13 14:00:00 |
| Summary | This reproduction required several hours of compute time, but the reproduction itself was straightforward. All the R code was provided, along with a working Dockerfile. |
| Repository | https://github.com/codecheckers/covid19model-nature |

**Table 1: CODECHECK summary**

## Summary

The R scripts provided by the authors were used to generate the main findings in the papers (tables and figures). All the main findings in the paper could be reproduced. Only one model figure (Extended data Figure 5) was not reproduced simply because the code was not available in the repository at the time of checking. However, this omission is minor. (NB: the results were checked against the "Accelerated Article Preview" version of the paper from 8th June 2020, rather than the final version of the article.) Overall, this was a straightforward reproduction, given the diligent documentation and supporting information describing the environment required to run the code.

| Output | Comment | Size (b) |
|---|---|---|
| nature/figures/France-three-pannel-base-nature-708913.png | Manuscript Figure 1 (France) | 171779 |
| nature/figures/Italy-three-pannel-base-nature-708913.png | Manuscript Figure 1 (Italy) | 178095 |
| nature/figures/Spain-three-pannel-base-nature-708913.png | Manuscript Figure 1 (Spain) | 174228 |
| nature/figures/United Kingdom-three-pannel-base-nature-708913.png | Manuscript Figure 1 (UK) | 180880 |
| nature/figures/covars-alpha-reductionbase-nature-708913.png | Manuscript Figure 2 | 95598 |
| nature/results/per-cases-model-base-nature-708913.csv | Manuscript Table 1 (Total population infected by country) | 411 |
| nature/figures/Belgium-three-pannel-base-nature-708913.png | Manuscript Extended Data Fig 1. (Belgium) | 174014 |
| nature/figures/Germany-three-pannel-base-nature-708913.png | Manuscript Extended Data Fig 1. (Germany) | 178676 |
| nature/figures/Sweden-three-pannel-base-nature-708913.png | Manuscript Extended Data Fig 1. (Sweden) | 168884 |
| nature/figures/Switzerland-three-pannel-base-nature-708913.png | Manuscript Extended Data Fig 1. (Switzerland) | 180706 |
| nature/figures/Austria-three-pannel-base-nature-708913.png | Manuscript Extended Data Fig 1. (Austria) | 174969 |
| nature/figures/Norway-three-pannel-base-nature-708913.png | Manuscript Extended Data Fig 1. (Norway) | 179195 |
| nature/figures/Denmark-three-pannel-base-nature-708913.png | Manuscript Extended Data Fig 1. (Denmark) | 175950 |
| nature/results/deaths-model-base-nature-708913.csv | Manuscript Extended Table 2 (column 3; model) | 485 |
| nature/results/deaths-null-base-nature-708913.csv | Manuscript Extended Table 2 (column 3; null) | 540 |
| nature/results/deaths-averted-base-nature-708913.csv | Manuscript Extended Table 2 (column 3; averted) | 546 |

**Table 2: Summary of output files generated**

## CODECHECKER notes

The github repository was cloned, and renamed to "covid19model-nature" (as there are two sets of papers in the one repository).

The programs were written in R and required a large number of dependencies, all of which were available. I created the following `codecheck-installs.R` script based on the contents of the `environment.yml`:

```
## Extra packages required
install.packages("bayesplot")
install.packages("data.table")
install.packages("EnvStats")
install.packages("lubridate")
install.packages("gdata")
install.packages("ggpubr")
install.packages("tidyr")
install.packages("dplyr")
install.packages("rstan")
install.packages("optparse")
install.packages("abind")
install.packages("svglite")
install.packages("jsonlite")
install.packages("zoo")
install.packages("gtable")
install.packages("ggrepel")
install.packages("scales")
install.packages("stringr")
install.packages("ggplot2")
install.packages("ggstance")
install.packages("gridExtra")
```

The code was first run using the Dockerfile, although this ran the base model, rather than the analysis for the Nature manuscript. The simulations were thus run by running the simulation directly on a workstation:

```
Rscript base-nature.r --full
```

The run took about 6 hours rather than the anticipated 3 hours, due to one chain taking much longer to sample from. (I also ran the test run, generated by omitting the –full flag; these are stored in the "nature-run-default" branch of my repository.)

Figures required no further post-processing after the R scripts were run, so these match the layout in the manuscript. The tables however required some simple formatting, as the outputs were provided in the form of CSV files. (Extended data table 1 was made by merging several data files, each column coming from a different CSV. The first column of extended data table 1 was missing.)

Given that the analysis in this paper is stochastic, and the random number seed was not fixed, the results in the paper and this run should not match exactly. There is very good agreement between the runs reported in the manuscript and those that were performed here.

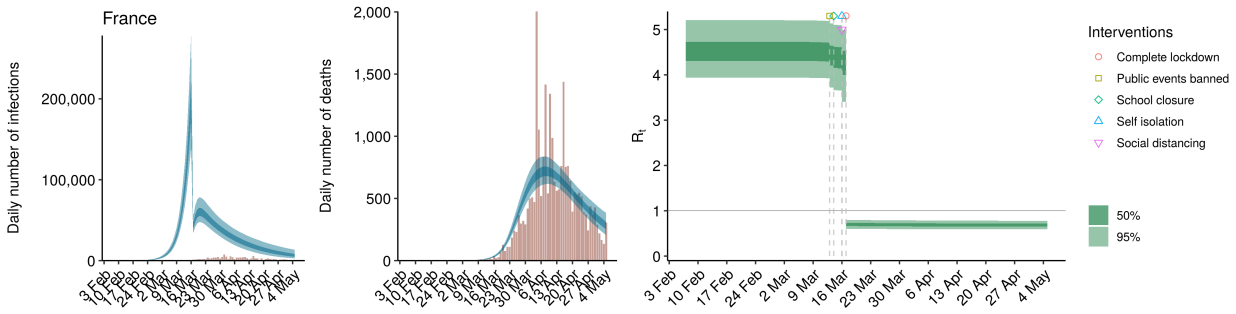


**Figure C1: Manuscript Figure 1 (France)**

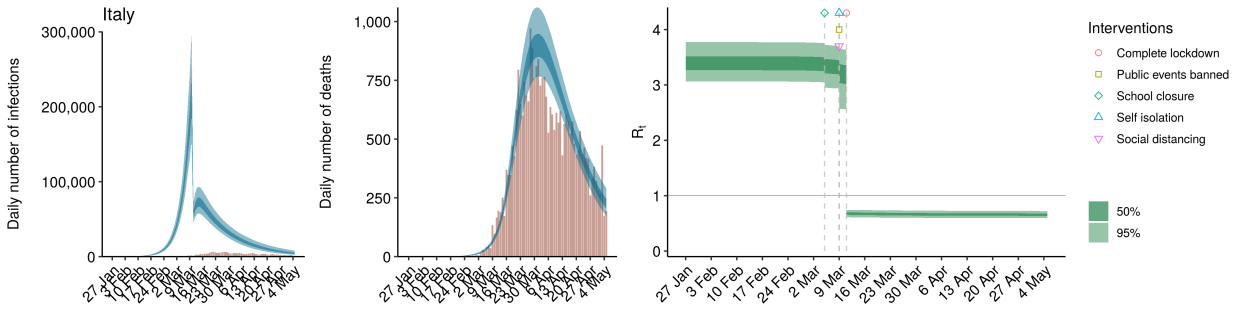


**Figure C2: Manuscript Figure 1 (Italy)**

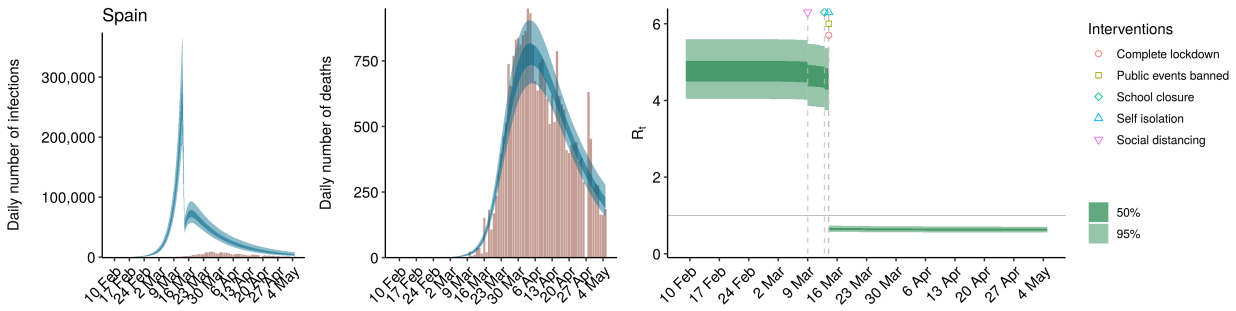


**Figure C3: Manuscript Figure 1 (Spain)**

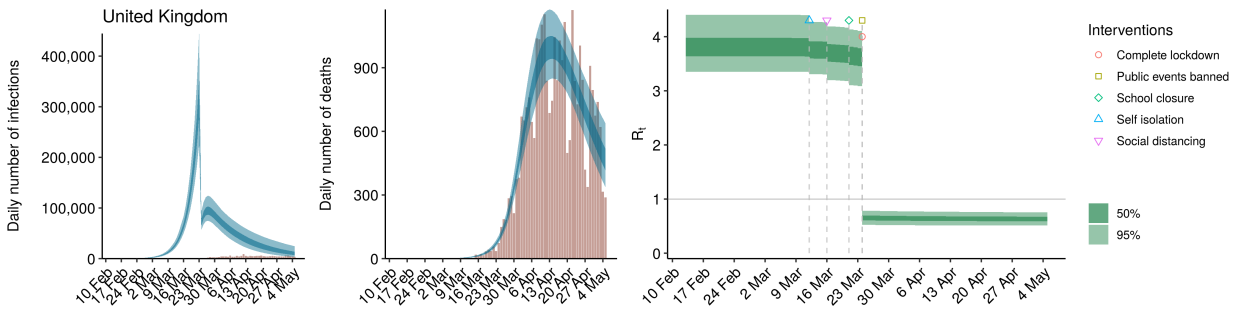


**Figure C4: Manuscript Figure 1 (UK)**

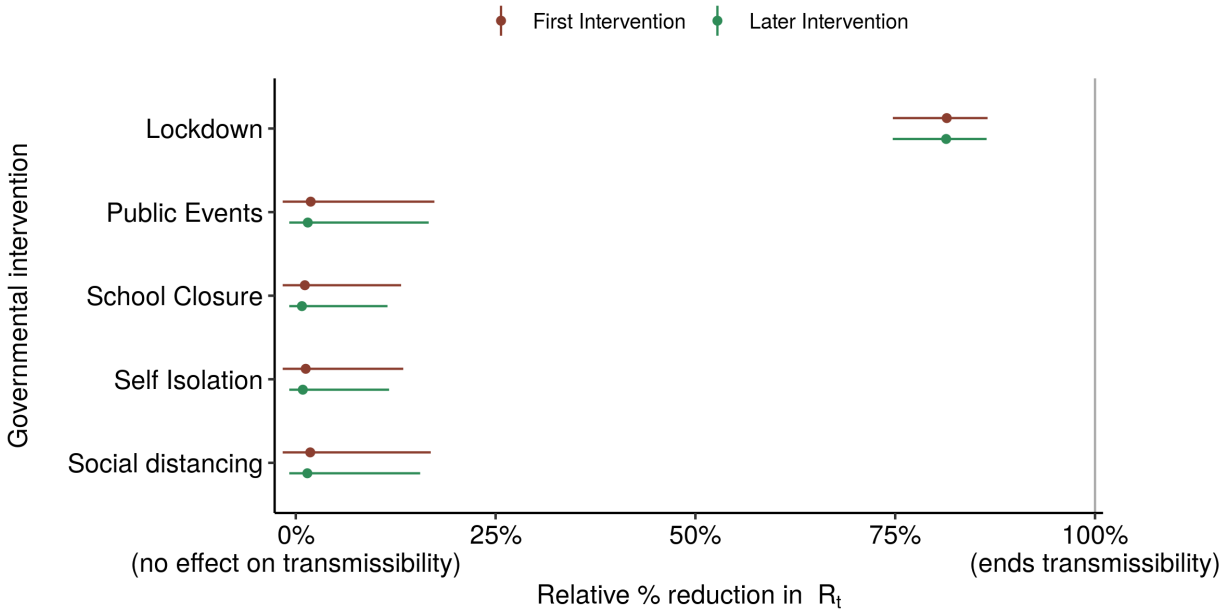


**Figure C5: Manuscript Figure 2**

| Country | Percent_Infected |
|---|---|
| Austria | 0.76 [0.59 - 0.99] |
| Belgium | 8 [6.1 - 11] |
| Denmark | 1 [0.79 - 1.4] |
| France | 3.4 [2.7 - 4.4] |
| Germany | 0.85 [0.65 - 1.1] |
| Italy | 4.6 [3.7 - 5.8] |
| Norway | 0.46 [0.34 - 0.61] |
| Spain | 5.5 [4.4 - 7] |
| Sweden | 3.8 [2.8 - 5.2] |
| Switzerland | 1.9 [1.5 - 2.4] |
| United_Kingdom | 5.1 [4 - 6.6] |

**Table C1: Manuscript Table 1 (Total population infected by country)**

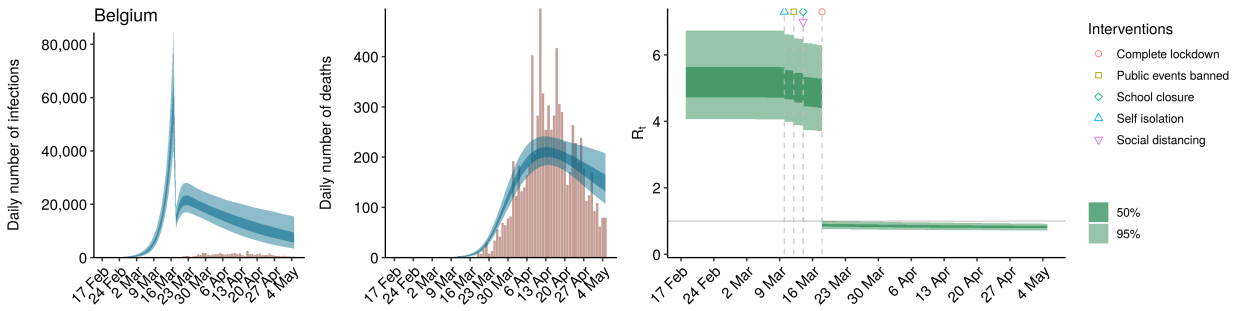


**Figure C6: Manuscript Extended Data Fig 1. (Belgium)**

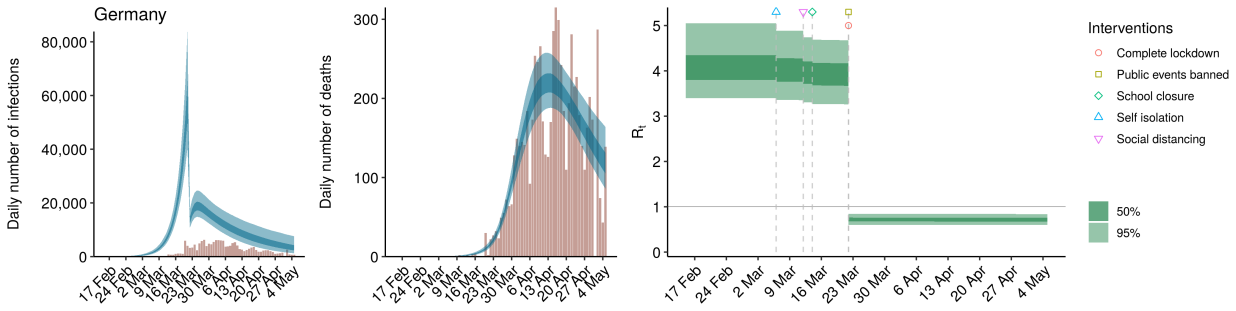


**Figure C7: Manuscript Extended Data Fig 1. (Germany)**

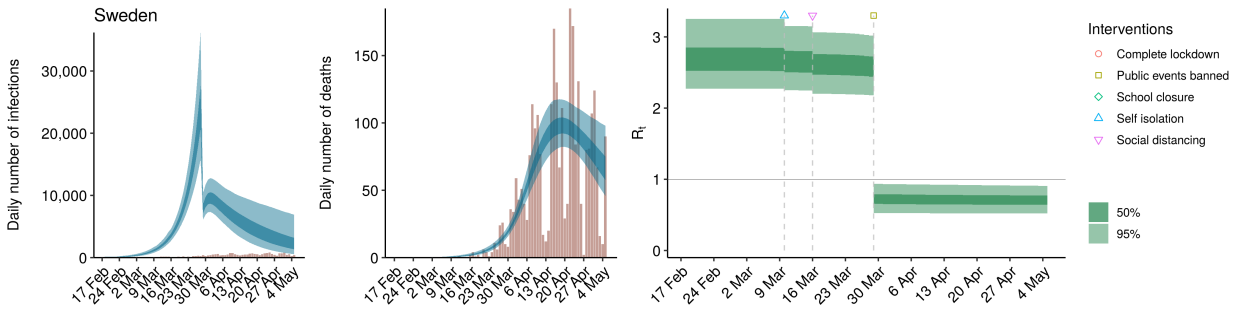


**Figure C8: Manuscript Extended Data Fig 1. (Sweden)**

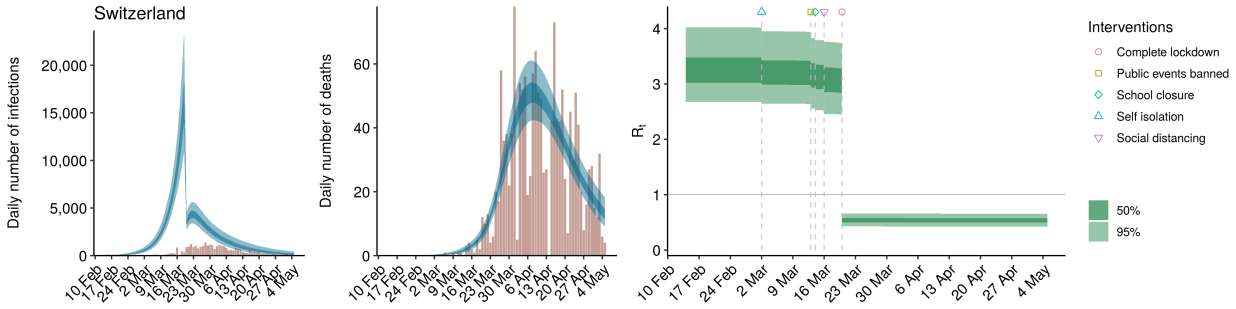


**Figure C9: Manuscript Extended Data Fig 1. (Switzerland)**

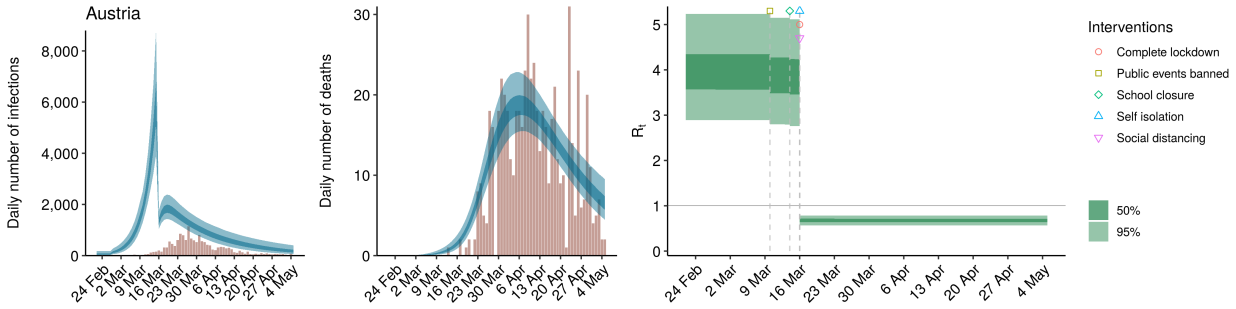


**Figure C10: Manuscript Extended Data Fig 1. (Austria)**

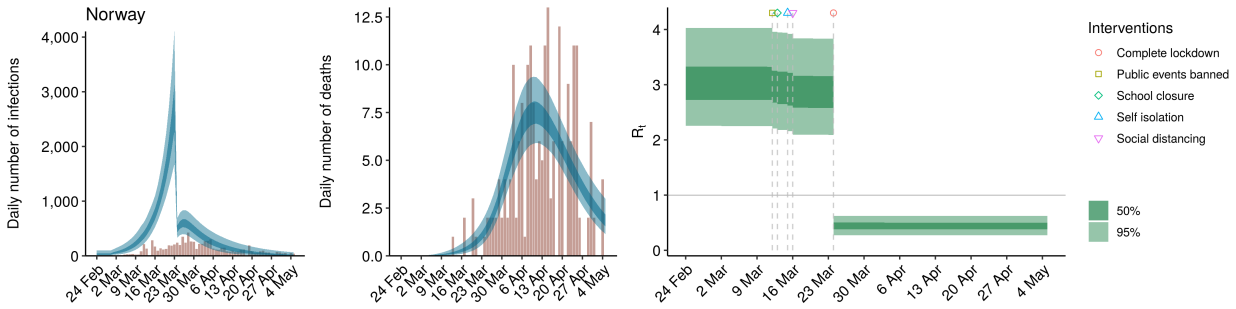


**Figure C11: Manuscript Extended Data Fig 1. (Norway)**

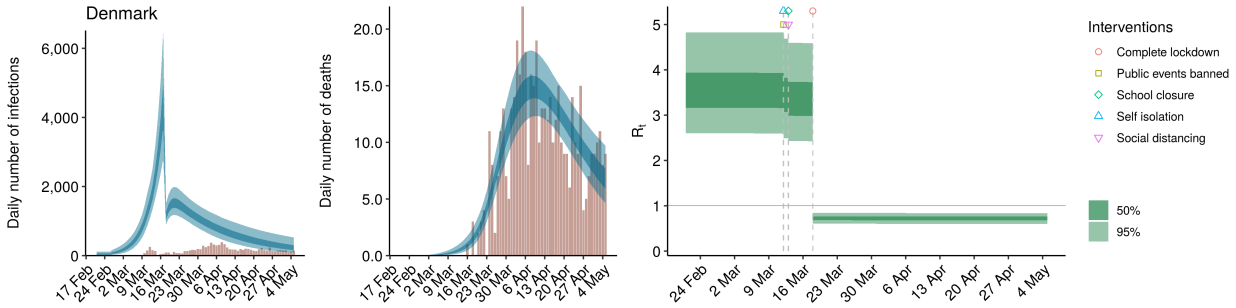


**Figure C12: Manuscript Extended Data Fig 1. (Denmark)**

| Country | model | null | averted |
|---|---|---|---|
| Austria | 620 [520 - 730] | 66,000 [39,000 - 87,000] | 65,000 [39,000 - 86,000] |
| Belgium | 7,300 [6,400 - 8,400] | 120,000 [92,000 - 140,000] | 110,000 [85,000 - 130,000] |
| Denmark | 500 [430 - 590] | 35,000 [17,000 - 49,000] | 34,000 [16,000 - 49,000] |
| France | 23,000 [21,000 - 27,000] | 710,000 [580,000 - 860,000] | 690,000 [550,000 - 830,000] |
| Germany | 6,900 [6,000 - 7,900] | 570,000 [370,000 - 8e+05] | 560,000 [370,000 - 790,000] |
| Italy | 31,000 [27,000 - 35,000] | 660,000 [540,000 - 790,000] | 630,000 [510,000 - 760,000] |
| Norway | 210 [170 - 250] | 12,000 [3,500 - 25,000] | 12,000 [3,300 - 25,000] |
| Spain | 25,000 [22,000 - 28,000] | 480,000 [390,000 - 570,000] | 450,000 [360,000 - 540,000] |
| Sweden | 2,800 [2,400 - 3,300] | 28,000 [15,000 - 49,000] | 25,000 [12,000 - 46,000] |
| Switzerland | 1,500 [1,300 - 1,800] | 54,000 [36,000 - 73,000] | 52,000 [34,000 - 71,000] |
| United_Kingdom | 29,000 [25,000 - 34,000] | 5e+05 [4e+05 - 610,000] | 470,000 [370,000 - 580,000] |
| All | 130,000 [120,000 - 140,000] | 3,200,000 [2,900,000 - 3,600,000] | 3,100,000 [2,800,000 - 3,500,000] |

**Table C2: Manuscript Extended Table 2 (column 3; model)**

## Citing this document

Stephen J. Eglen (2020). CODECHECK Certificate 2020-011. Zenodo. https://doi.org/10.5281/zenodo.3893138

## About CODECHECK

This certificate confirms that the codechecker could independently reproduce the results of a computational analysis given the data and code from a third party. A CODECHECK does not check whether the original computation analysis is correct. However, as all materials required for the reproduction are freely available by following the links in this document, the reader can then study for themselves the code and data.

## About this document

This document was created using R Markdown using the `codecheck` R package. `make codecheck.pdf` will regenerate the report file.

```
sessionInfo()
```

```
## R version 4.0.0 (2020-04-24)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Manjaro Linux
##
## Matrix products: default
## BLAS:   /usr/lib/libopenblasp-r0.3.9.so
## LAPACK: /usr/lib/liblapack.so.3.9.0
##
## locale:
##  [1] LC_CTYPE=en_GB.UTF-8       LC_NUMERIC=C
##  [3] LC_TIME=en_GB.UTF-8        LC_COLLATE=en_GB.UTF-8
##  [5] LC_MONETARY=en_GB.UTF-8    LC_MESSAGES=en_GB.UTF-8
##  [7] LC_PAPER=en_GB.UTF-8       LC_NAME=C
##  [9] LC_ADDRESS=C               LC_TELEPHONE=C
## [11] LC_MEASUREMENT=en_GB.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets
## [6] methods   base
##
## other attached packages:
##  [1] readr_1.3.1          tibble_3.0.1
##  [3] rprojroot_1.3-2      codecheck_0.0.0.9005
##  [5] jsonlite_1.6.1       knitr_1.28
##  [7] rmarkdown_2.2.5      parsedate_1.2.0
##  [9] assertthat_0.2.1     R.cache_0.14.0
## [11] gh_1.1.0             stringr_1.4.0
## [13] yaml_2.2.1           xtable_1.8-4
## [15] zen4R_0.3-1
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.4.6      highr_0.8         compiler_4.0.0
##  [4] pillar_1.4.4      R.methodsS3_1.8.0 R.utils_2.9.2
##  [7] tools_4.0.0       digest_0.6.25     evaluate_0.14
```

```
## [10] lifecycle_0.2.0   pkgconfig_2.0.3   rlang_0.4.6
## [13] cli_2.0.2         xfun_0.14         httr_1.4.1
## [16] xml2_1.3.2        hms_0.5.3         vctrs_0.3.1
## [19] glue_1.4.1        R6_2.4.1          fansi_0.4.1
## [22] magrittr_1.5      backports_1.1.6   htmltools_0.4.0
## [25] ellipsis_0.3.1    rvest_0.3.5       stringi_1.4.6
## [28] crayon_1.3.4      R.oo_1.23.0
```