# Mathematical modeling and prediction of COVID-19 cases, hospitalisation (including intensive care and ventilation units) and deaths in the German states

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# Summary


### Aims

- The aim of this project is to develop a mechanistic mathematical model to predict COVID-19 infections including hospital bed occupancy, intensive care units (ICU), ventilation and death rates in the individual German federal states and to estimate non-pharmaceutical interventions (NPI, e.g. school closure) over time.
- The model will be used to predict the further course of infections (including hospital occupancy, ICU, ventilation, death rates) and to simulate various possible scenarios (e.g. lifting of lockdown).
- The model and the predictions will be adjusted with new data at regular intervals (every one to two weeks). New predictions for all federal states are made available as PDF reports. The website www.covid-simulator.com serves as an online platform for the transmission of information and for the provision of an online simulator.

### Results

- A modified infection model (Susceptible - Exposed - Infectious - Recovered - Death; SEIRD) has been developed and adapted to the respective situation of each federal state. The model shows an excellent descriptive characteristic of COVID-19 case numbers, occupancy of inpatient beds, intensive care beds (ventilated and non-ventilated), deaths and recoveries in all 16 German federal states.
- The influence of non-pharmaceutical interventions (NPI) on R(t) was investigated:
  - At the beginning of the infection occurrence the R(t) value in Germany lies on average at 2.78.
  - School closure, lockdown (on 23.03.2020) and a subsequent lockdown (on 01.04.2020) have a significant effect ($p<0.001$) on the reduction of R(t). Due to the close alignment of NPIs, it cannot be ruled out that the effects of other NPIs are overlapped. The reproduction number R(t) decreases from the initial value of R(t) = 2.78 to R(t) = 0.636 on a national average on 01.04.2020.
  - Subsequently, in April, even slighter but statistically significant ($p<0.001$) changes of R(t) occurred. On 25.04.2020, 5 days after opening of shops (20.04.2020), state specific R(t) changes were observed.
  - On 06.05.2020 (two days after school reopening on 04.05.2020), there was a small increase of R(t) by 13% on average to 0.716. After 05.06.2020, there was a further increase of R(t) by approx. 51% from 0.716 to 1.08 on a national average with subsequent reduction of R(t) after 17.06.2020 by about 21% from 1.08 to 0.857.
  - On 12.07.2020, a new increase of R(t) by approx. 55% from 0.857 to 1.33 on average can be observed, followed by reduction of R(t) after 09.08.2020 by about 21% from 1.33 to 1.05 on a national average.
  - On 19.08.2020, a reduction of R(t) by approx. 9% from 1.05 to 0.955 on average can be observed, followed by an increase of R(t) after 05.09.2020 by about 29% from 0.955 to 1.23.

- On 01.10.2020 a further increase of R(t) by approx. 24% from 1.23 to 1.52 on a national average can be observed.
- Following the relaxation of NPIs nationwide, a general increase in infections has been observed. The R(t) changes in June seem to depict emergence of the local "corona hotspots" in some federal states (e.g. North Rhine-Westphalia, Berlin, Brandenburg, Saxony-Anhalt) followed by containment of this local outbreaks. In the time period from July to August, however, the rising number of positively tested individuals among incoming travellers have also played an increasingly important role. In September, a renewed increase in the number of cases with the state-specific R(t) value above 1.0 was observed. Smaller outbreaks in various districts increasingly contribute to the rising case numbers.
- The current R(t) values are estimated at 1.52 on a national average and lie above 1.0 for all of 16 federal states.

- Changes in hospitalization and inpatient mortality over time.
  - The estimated hospitalization rate has decreased over time. At the beginning of the pandemic the rate was around 20% of all confirmed cases and it is currently below 10%. The hospitalization rate is strongly correlated with the age structure of infected COVID-19 population. Particularly the proportion of patients over 60 years of age determines the hospitalization rate. This percentage has decreased from over 35% initially to less than 10% in the meantime. With an increased number of infections among older patients, a rising hospitalization rate can be expected, even if the number of new infections remains the same.
  - Inpatient mortality rates (normal ward, ICU ventilated and non-ventilated) decrease significantly over time, similar to the hospitalization rate. This can also be attributed to the decreasing age of the infected patients. In this case, an increase in hospital mortality can also be expected if a higher number of elderly patients become infected again.

- Forecasts with different assumptions of R0 are presented for each federal state.
  - Assuming that the reproduction rate (R(t)) in the federal states adopts a value below 1, the bed capacity of the hospitals appears to be sufficient in all federal states.
  - If the R(t) value remains the same, COVID-19 hospital occupancy numbers (normal ward and ICU) can be expected to reach the same level as at the peak times of the first wave in the next 2-4 weeks.

- The Robert Koch Institute (RKI) publishes regular updates on the current R0 figures in Germany and the federal states. The method of calculating the R0 number of the RKI differs significantly from our model approach. The RKI only considers new infections in the last 8 days, whereas our model considers the complete data set (extent and also other data, such as hospital stays, deceased, convalescence). Due to the short time period of the RKI data considered, their R0 value is more susceptible to changes and fluctuations in reporting and also sensitive in the range of small numbers of new infections. The R0 value of the RKI therefore fluctuates more over time compared to the R(t) value calculated by our model. Still by comparing the R0 values calculated by the RKI and our calculated R(t) values, a large agreement could be found over a long period of time (results on demand).

# Changes in the document

(The last 5 changes are listed)

**Changes compared to the report of 07.10.2020**

Compared to the last report, the database has been expanded and the model has been estimated with new data up to 13.10.2020. A further effect on R(t) on 01.10 was estimated (p-value $< 0.001$). The structure of the report has been slightly modified.

**Changes compared to the report of 23.09.2020**

Compared to the last report, the database has been expanded and the model has been estimated with new data up to 06.10.2020. A further effect on R(t) on 04.09 was estimated (p-value $< 0.001$).

**Changes compared to the report of 10.09.2020**

Compared to the last report, the database has been expanded and the model has been estimated with new data up to 22.09.2020. A further effect on R(t) on 18.08 was estimated (p-value $< 0.001$).

**Changes compared to the report of 27.08.2020**

Compared to the last report, the database has been expanded and the model has been estimated with new data up to 09.09.2020. No further effect on R(t) was estimated. A further effect on the hospitalization rate was estimated (p-value $< 0.001$).

**Changes compared to the report of 13.08.2020**

Compared to the last report, the database has been expanded and the model has been estimated with new data up to 26.08.2020. A further effect on R(t) on 08.08 was estimated (p-value $< 0.001$).

# Contents

# 1 Overview of the modeling

## 1.1 Question

Infections of humans with the SARS coronavirus-2 (the resulting disease is known as "COVID-19") are increasing rapidly in Germany and the world. This results in rising hospitalisation rates and also an increased occupancy of intensive care beds (ICU) as well as the use of ventilation capacities. In the course of the pandemic, various non-pharmaceutical interventions (NPI) were introduced (e.g. school closure) in order to delay the spread of the pandemic and not to exceed the stress limits of the health care system. Unfortunately, predicting the further course of infection, the workload of the health care system and the influence of NPIs on the course of the disease is a difficult task. This can only be achieved by mathematical modeling and simulation.

## 1.2 Objectives

- The aim of this project is to develop a mechanistic mathematical model to predict COVID-19 infections including hospital bed occupancy, intensive care units (ICU), ventilation and death rates in the individual German states and to estimate non-pharmaceutical interventions (NPI, e.g. school closure) over time.
- The model will be used to predict the further course of infections (including hospital occupancy, ICU, ventilation, death rates) and to simulate various possible scenarios (e.g. lifting of lockdown).
- The model and the predictions will be adjusted with new data at regular intervals (every one to two weeks). New predictions for all federal states are made available as PDF reports. The website www.covid-simulator.com serves as an online platform for the transmission of information and for the provision of an online simulator.

## 1.3 Target group

- The model is intended to help authorities, politicians and the health care system to better estimate the course of the current SARS coronavirus-2 pandemic in the short and medium term and to plan capacities. Furthermore, the influence of NPIs (e.g. lockdown) can be estimated by these groups of people, either justifying them or justifying their lifting.
- On the other hand, the model presented can be used to illustrate to the population the influence of interventions on the course of infection, thereby encouraging them to abide the NPIs.

## 1.4 Methods

- The following data sources serve as a basis:

  - Database Berliner Morgenpost: (www.morgenpost.de)
    * Data sources from the Morgenpost: Johns Hopkins University CSSE (international data from WHO, CDC (USA), ECDC (Europe), NHC, DXY (China) and reports from the German authorities (Robert Koch Institute and district and state health authorities)
  - MetaKIS: Documentation of anonymized billing data from more than 250 hospitals throughout Germany
  - Information from the Saarland and other health ministries
  - Results of literature search on intervention measures in the federal states
  - DIVI Intensive Care Register

- The modeling is done using the Non-Linear Mixed Effects (NLME) approach and is performed in the software NONMEM® (Version 7.4.3)
- Statistical analysis, graphical display and report generation were performed with R® (version 3.6.3) and R-Studio® (version 1.2.5033)
- An approved ethics application of the ethics committee of the medical association of the Saarland has been submitted
- A detailed description of the model structure and the parameterization will be available in the forthcoming publication

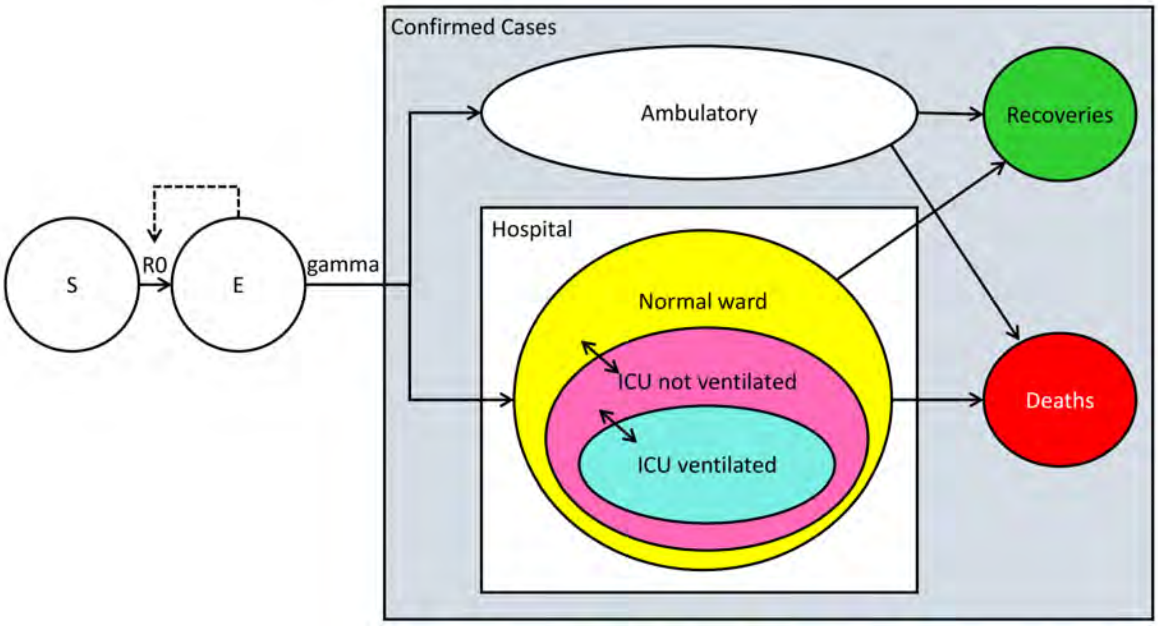
## 1.5 Model structure

The developed model is based on a classical SEIR model, which in mathematical epidemiology describes the spread of infections within a population. In this classical model, an individual can pass through four disease-relevant stages: *Stage S:* People who can be infected, *Stage E:* People who are infected, can be infectious, but are not yet identified as infected, *Stage I:* Infected people, *Stage R:* Cured people.

The more advanced SEIR/D model describes more complex relationships. In addition to the stages S, E and R, a distinction is made for infected people between *stage C:* Infected people who remain outpatients, *stage CH:* Infected in hospital, *stage ICU:* Infected in intensive care unit and *stage ICU ventilated:* Infected people requiring mechanical ventilation. In addition, the model was extended to include *stage D:* Infected people who have died. Likewise to stage C, *stage R* was divided into *stage KH R:* patients recovered during the hospital stay, and *stage R:* people recovered outside the hospital.

People from *stage E* infect people from *stage S*. The factor *R0 or R(t) (basic reproduction number)* indicates how many people from stage S are infected on average by a single person from stage E. Infected people in stage E are only identified as infected after a certain time (*gamma*) and thus reach stage C (C: Cases = confirmed cases). Infected persons (C) can either be recovered on an outpatient basis (R) or admitted to hospital as inpatients (KH). The inpatient group is splitted into three subgroups: Patients at normal ward, patients at ICU and patients at ICU that require mechanical ventilation. From all three subgroups, patients can recover or die with different rates.

The model structure with the different stages and their transitions is shown in Fig.1. The given data (duration of hospitalization, percentage of patients, ventilation, etc.) are taken from hospital data of more than 3000 German COVID-19 patients from more than 250 hospitals, which were derived anonymously from the MetaKIS system.




| | Distribution [%] | | Ratio [%] | Duration [days] | ICU [% Duration] | Ventilation [% Duration] |
|---|---|---|---|---|---|---|
| Normal ward | 80.1 | recovered | 84.5 | 12 | - | - |
| | | deceased | 15.5 | 8.8 | - | - |
| ICU not ventilated | 5.0 | recovered | 79.6 | 19 | 34 | - |
| | | deceased | 20.4 | 13 | 57 | - |
| ICU ventilated | 14.9 | recovered | 48.6 | 35 | 75 | 49 |
| | | deceased | 51.4 | 13 | 88 | 76 |

Figure 1: SEIR/D Model - Model structure

## 1.6 Model results

### 1.6.1 Description of the data

Using the SEIR/D model developed in Section 1.5 Model Structure, the COVID-19 case numbers for infections, hospital bed occupancy (acute and cumulative hospital beds), ICU occupancy (acute and cumulative), recovery and deaths can be described in the Federal Republic of Germany and separately for each federal state.

Fig. 2 shows the model description of the case numbers (line) and the reported case numbers (dots) for each federal state over time for infection numbers (blue), recovery numbers (green), deaths (red), occupied hospital beds acute and cumulative (magenta), occupied ICU beds acute (yellow) and cumulative (orange), and number of ventilated intensive care patients (cyan).

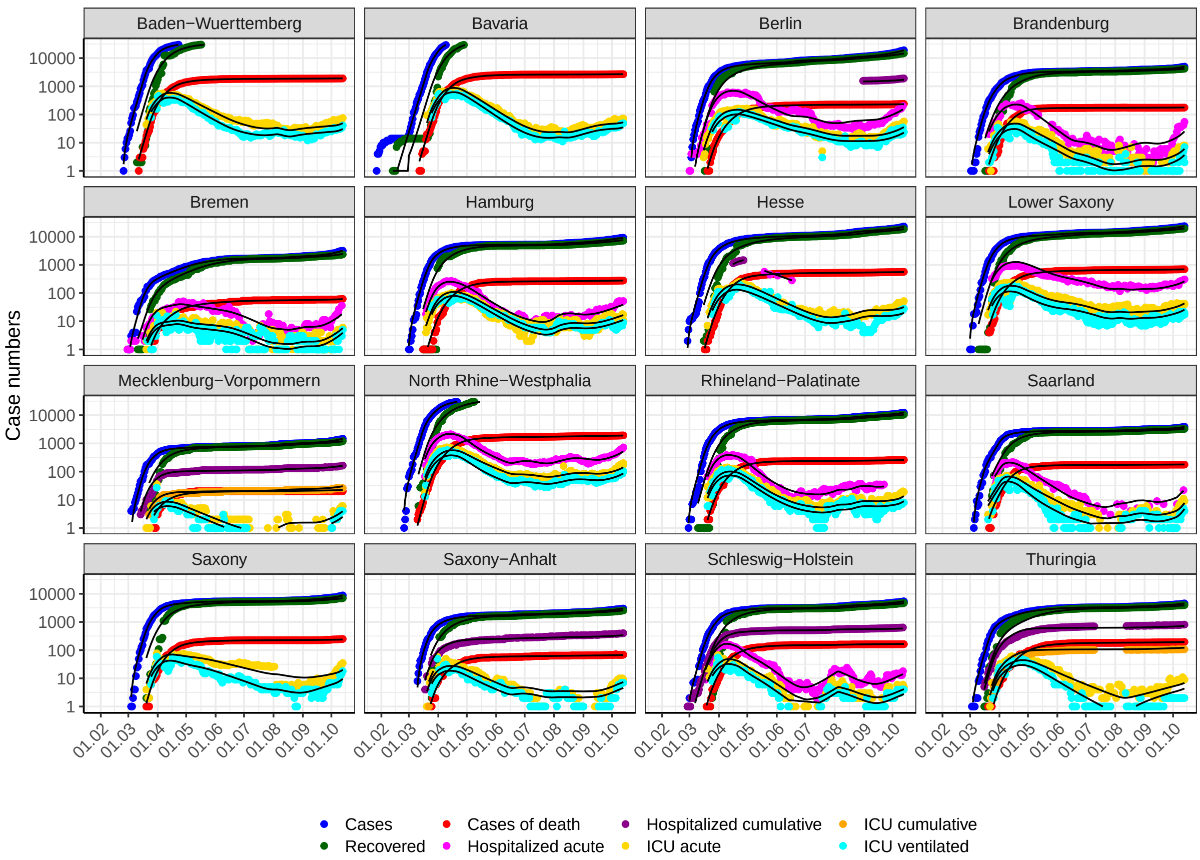



Figure 2: Germany by federal states - model description of case numbers.
Points: Reported case numbers - Lines: Model description

Fig. 3 and 4 show the model description of the infection numbers (line) and the reported infection numbers (points) for each state over time in linear (3) and semi-logarithmic (4) representation.

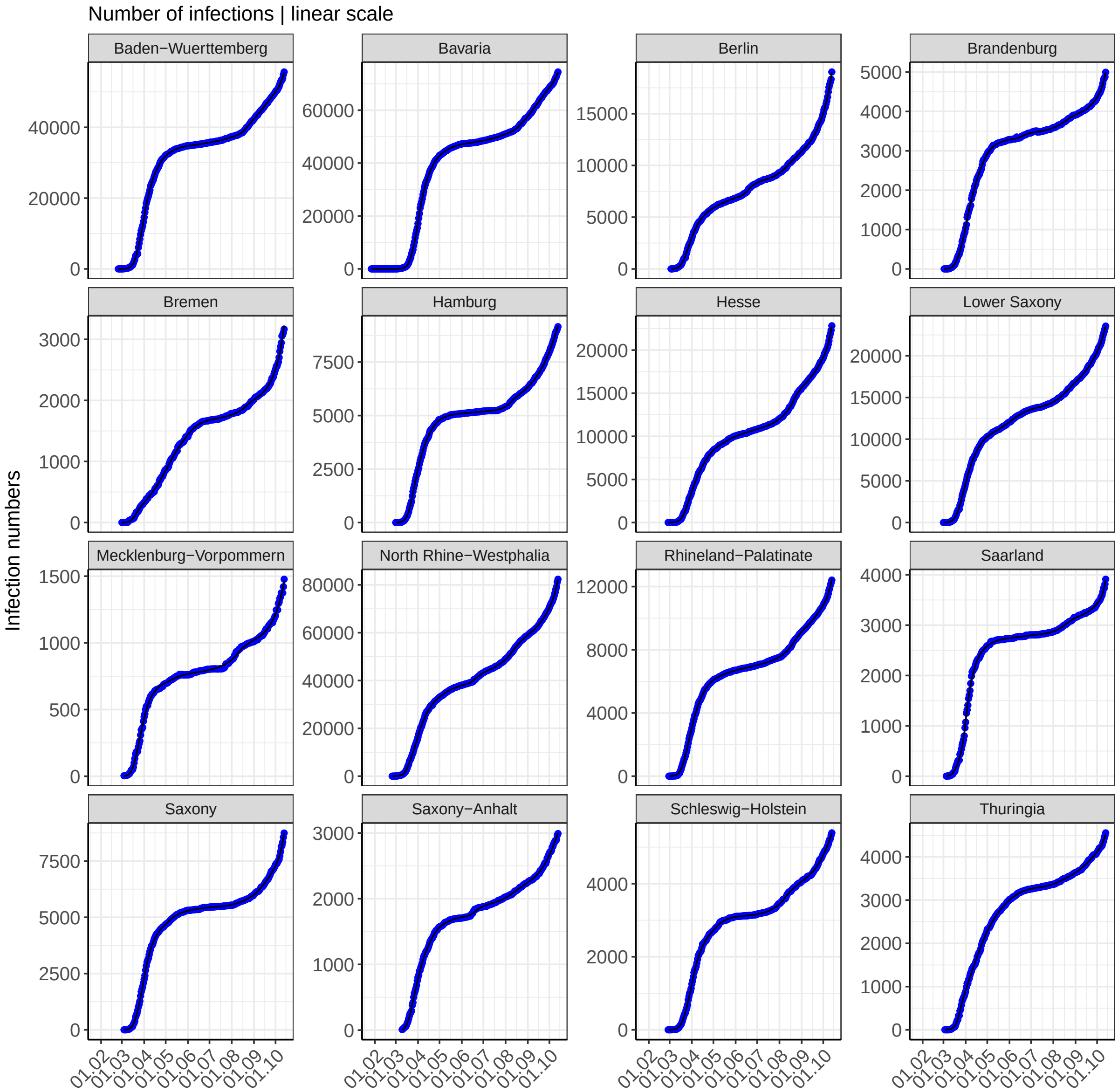



Figure 3: Germany by federal states - model description of the infection cases.
Points: Reported cases of infection - Lines: Model description

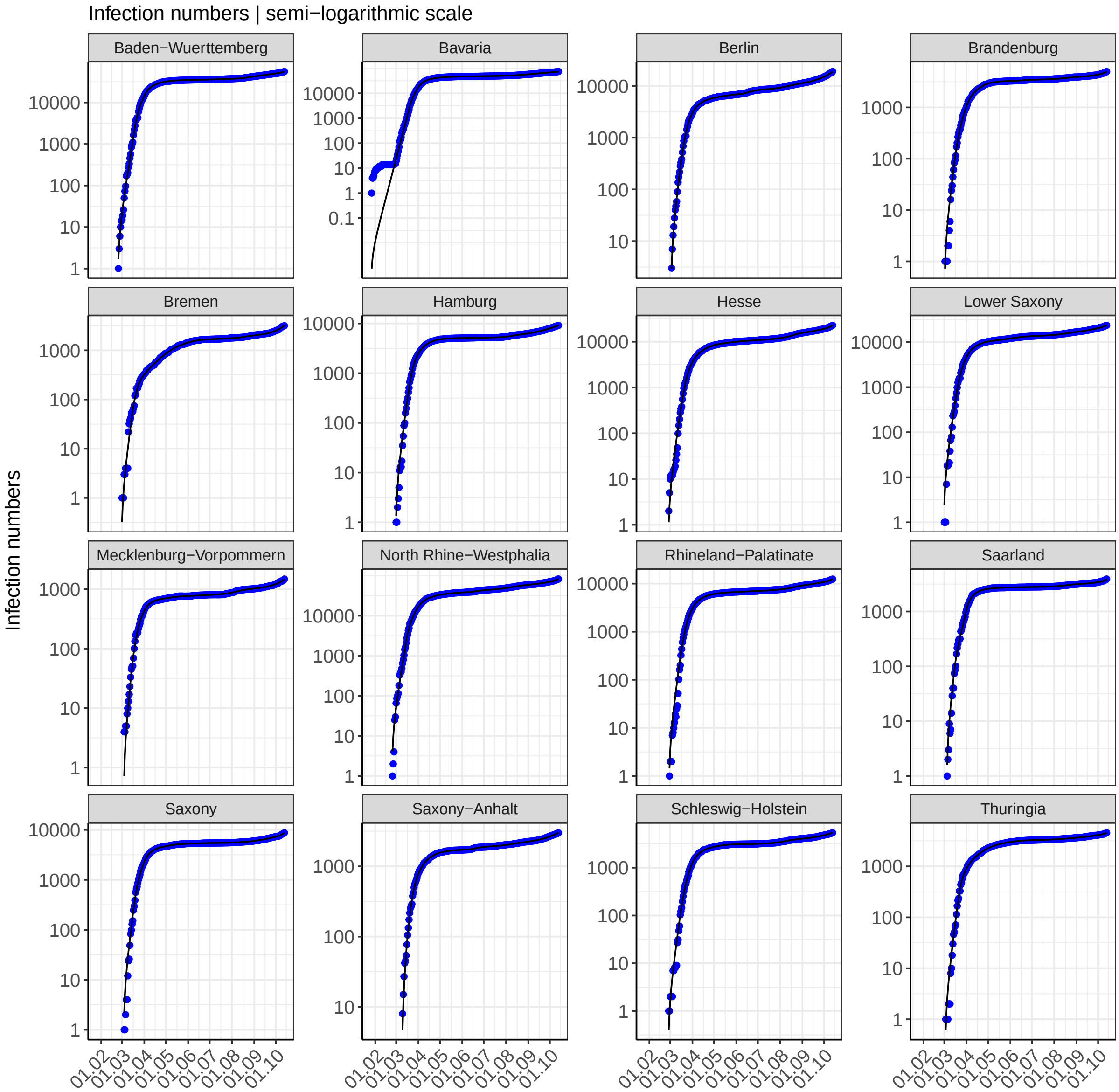



Figure 4: Germany by federal states - model description of infection cases.
Points: Reported cases of infection - Lines: Model description

Fig. 5 shows the model description of the occupied beds and ventilated patients (line) and the reported occupancy of the hospital and ICU beds and ventilated patients (dots) for each federal state over time. The occupancy of the hospital and ICU beds is shown acutely and/or cumulatively.

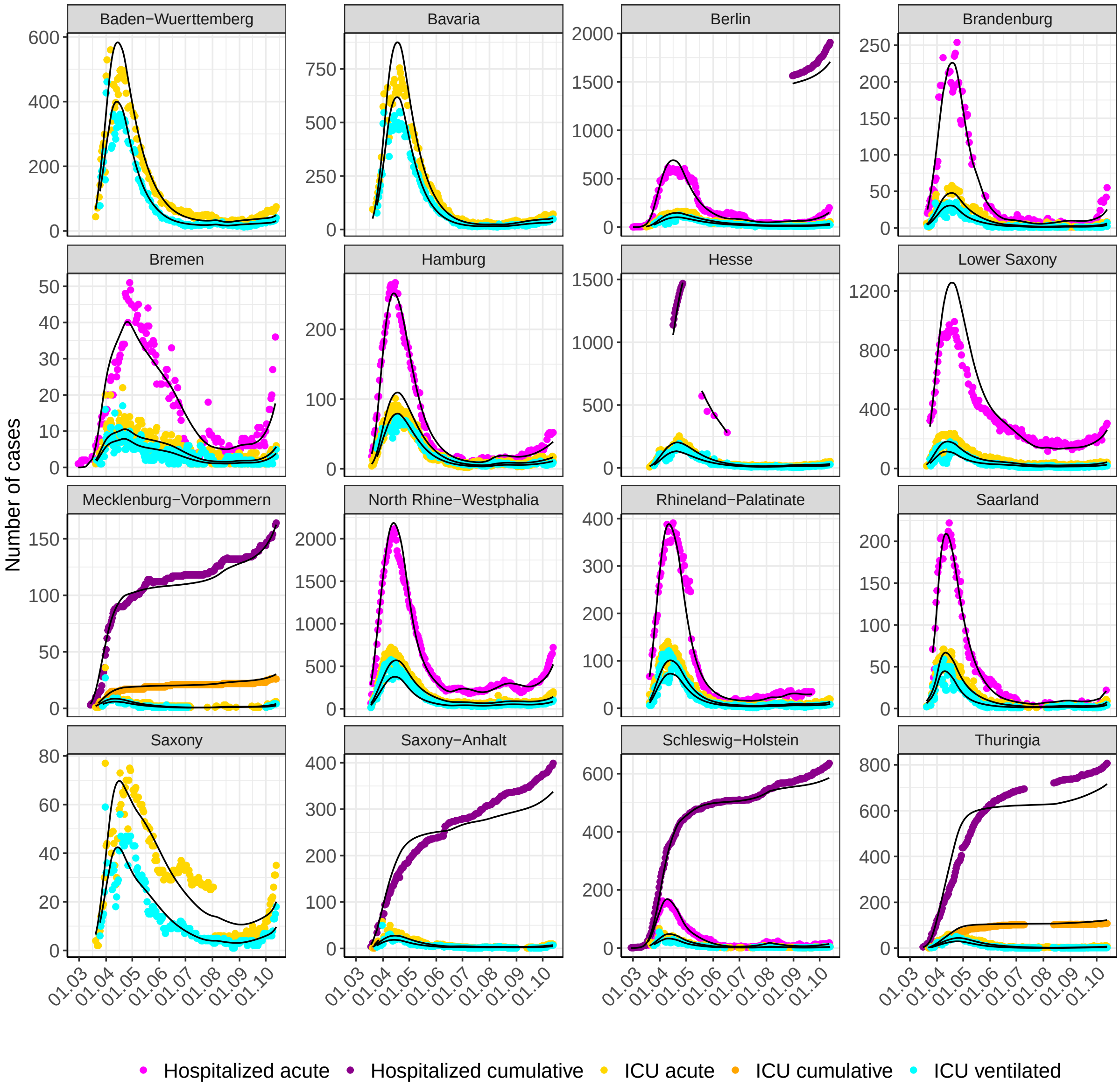



Figure 5: Germany by federal states - model description of the hospital and ICU occupancy. Points: Reported occupancy - Lines: Model description

Fig. 6 shows the model description of the patients recovered from COVID-19 (line) as well as the reported cases of recovered patients (points) for each federal state over time.

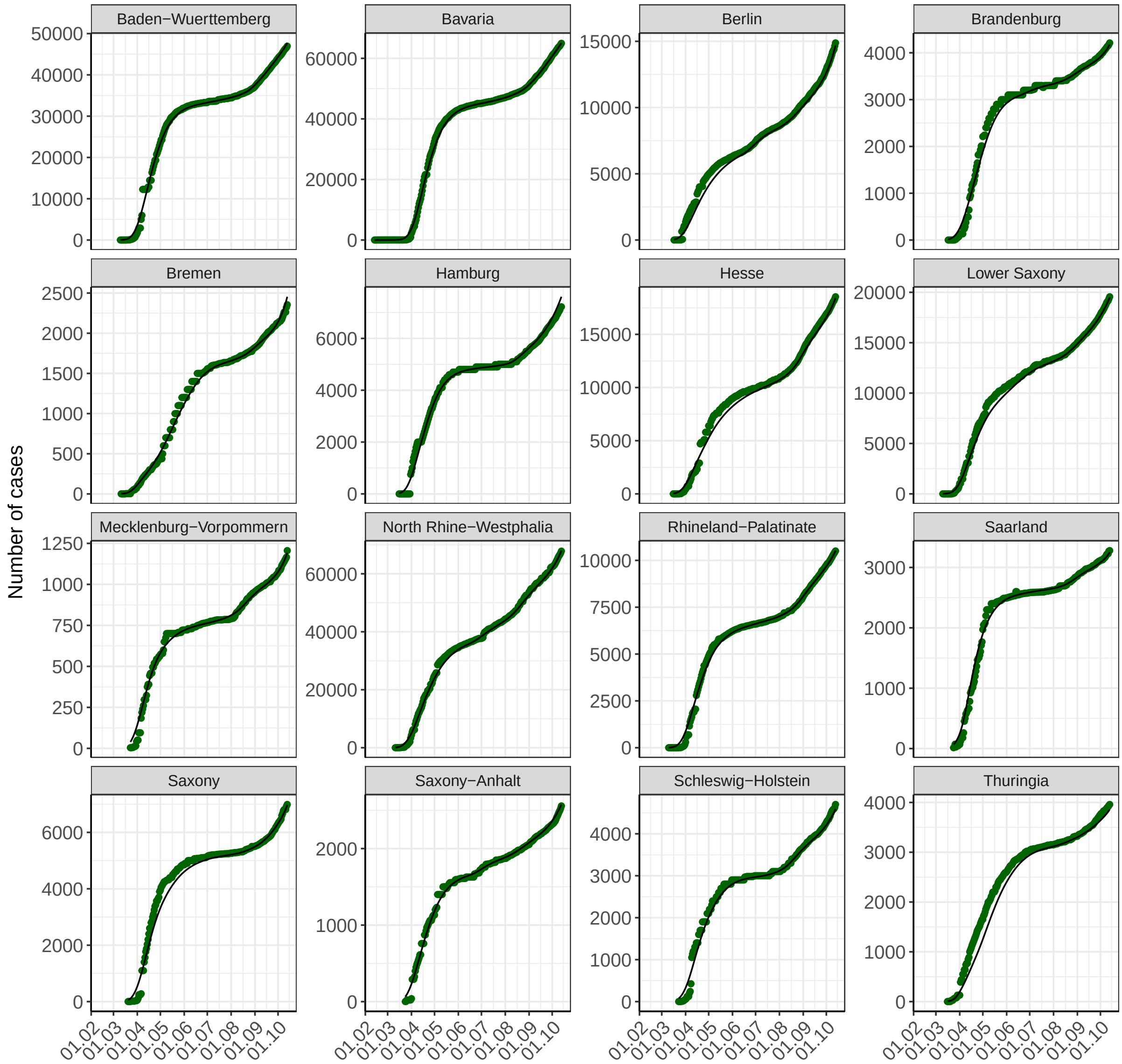



Figure 6: Germany by federal states - model description of patients recovered from COVID-19.
Points: Reported numbers - Lines: Model description

Fig. 7 shows the model description of the patients who died of COVID-19 (line) and the reported death numbers (points) for each state over time.

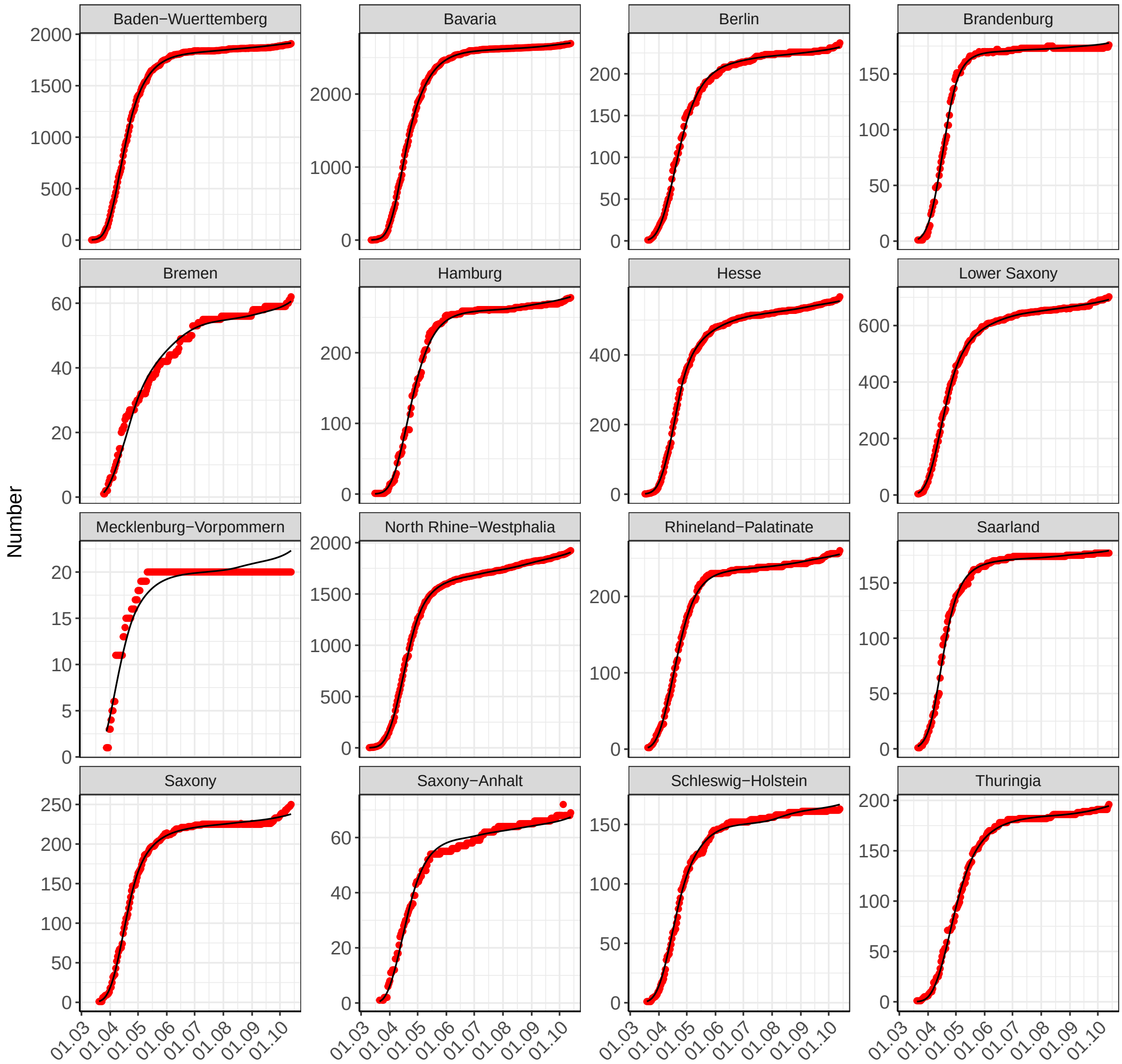



Figure 7: Germany by federal states - model description of deaths.
Points: Reported deaths - Lines: Model description

Fig. 8 shows a goodness-of-fit (GOF) plot, the graphical representation of the goodness-of-fit of the model. The values calculated by the model are plotted against the raw data. If the pairs of values were 100% identical, all data points would be located on the identity line. The points are distributed evenly around the identity line. This reflects the good descriptive performance of the model.

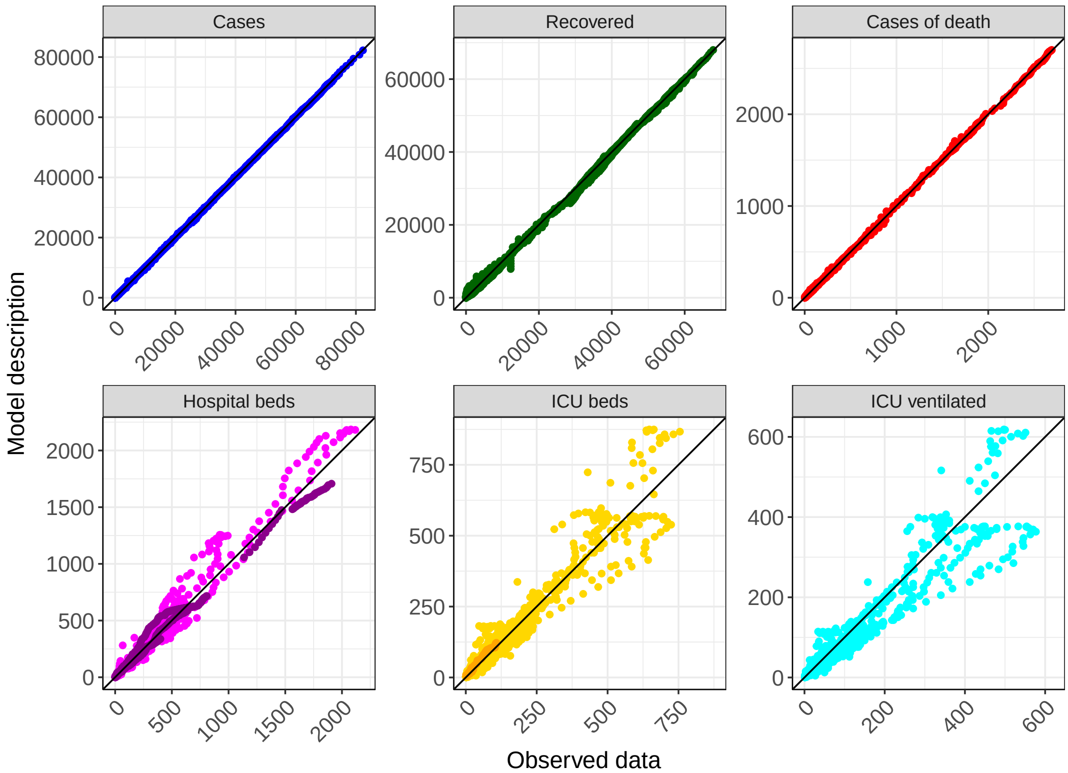



Figure 8: Germany - Goodness-of-fit plot: reported data vs. model description

### 1.6.2 Influence of non-pharmaceutical interventions (NPI) and other structural changes

The influences of NPIs and other events were systematically investigated and incorporated into the model. Investigations of influencing factors on R(t) revealed the following statistically significant effects: school closure, lockdown, a “2nd stage” of the lockdown since 01.04.2020 and changes on 25.04.2020, 06.05.2020, 05.06.2020, 17.06.2020, 12.07.2020, 09.08.2020, 19.08.2020, 05.09.2020 and 01.10.2020. The effects vary slightly in each federal state (see Table 1, figures [9] and [10]), while the exact causes are not clear. It can be assumed that the geographical situation of the federal states (“rural” states vs. “urban” states, border region, mentality) as well as local policies play a role. Two days after the school reopening on 04.05.2020, the R(t) value increased by approx. 13% to 0.716 on a national average. In general, the safety measures taken appear to have been effective in keeping R(t) at a stable level below 1, with the exception of the federal states with known “corona hotspots”. Since the beginning of the easing of the NPIs and especially since the beginning of the current holiday season (high incidence among incoming travellers) a new increase of the R(t) value has been observed. In addition, smaller local outbreaks are also playing an increasingly important role. The factors influencing R(t) are listed in detail below:

- School closures: Reduction of R(t) on average by approx. 31% from 2.78 to 1.92 (p-value $< 0.001$)
- Lockdown (on 23.03.2020): Reduction of R(t) on average by approx. 43% from 1.92 to 1.1 (p-value $< 0.001$)
- “2nd stage” of the lockdown (on 01.04.2020): Reduction R(t) on average by approx. 42% from 1.1 to 0.636 (p-value $< 0.001$)
- From 06.05.2020: Increase of R(t) by 13% to 0.716 (p-value $< 0.001$).
- From 05.06.2020: Increase of R(t) by 51% from 0.716 to 1.08 (p-value $< 0.001$).
- From 17.06.2020: Reduction of R(t) by 21% from 1.08 to 0.857 (p-value $< 0.001$).
- From 12.07.2020: Increase of R(t) by 55% from 0.857 to 1.33 (p-value $< 0.001$).
- From 09.08.2020: Reduction of R(t) by 21% from 1.33 to 1.05 (p-value $< 0.001$).
- From 19.08.2020: Reduction of R(t) by 9% from 1.05 to 0.955 (p-value $< 0.001$).
- From 05.09.2020: Increase of R(t) by 29% from 0.955 to 1.23 (p-value $< 0.001$).
- From 01.10.2020: Increase of R(t) by 24% from 1.23 to 1.52 (p-value $< 0.001$).

Table 1 lists the R(t) values after the introduction of the individual NPIs for each federal state. The values for Germany may differ slightly in this table due to different calculation methods.

Table 1: R(t) value before and after the NPIs

| Federal state | Initial value | School closures | Lockdown | From 01.04. | From 25.04. | From 06.05. | From 05.06. | From 17.06. | From 12.07. | From 09.08. | From 19.08. | From 05.09. | From 01.10. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baden-Wuerttemberg | 2.78 | 1.75 | 1.30 | 0.59 | 0.55 | 0.60 | 1.16 | 1.06 | 1.20 | 1.71 | 1.00 | 1.05 | 1.61 |
| Bavaria | 2.78 | 2.79 | 1.51 | 0.57 | 0.56 | 0.67 | 0.94 | 1.13 | 1.18 | 1.47 | 1.14 | 0.99 | 1.44 |
| Berlin | 2.78 | 1.99 | 1.01 | 0.62 | 0.78 | 0.90 | 1.79 | 0.58 | 1.33 | 0.95 | 1.01 | 1.32 | 1.47 |
| Brandenburg | 2.78 | 1.91 | 1.38 | 0.78 | 0.44 | 0.53 | 1.81 | 0.64 | 1.35 | 1.14 | 0.80 | 1.34 | 1.76 |
| Bremen | 2.78 | 1.46 | 0.70 | 1.13 | 1.05 | 0.88 | 0.55 | 0.67 | 1.28 | 1.44 | 0.85 | 1.43 | 1.58 |
| Hamburg | 2.78 | 2.14 | 0.93 | 0.64 | 0.29 | 0.60 | 1.07 | 1.07 | 1.59 | 0.63 | 1.20 | 1.22 | 1.20 |
| Hesse | 2.78 | 2.09 | 1.09 | 0.77 | 0.60 | 0.85 | 0.84 | 1.04 | 1.30 | 1.42 | 0.72 | 1.19 | 1.72 |
| Mecklenburg-Vorpommern | 2.78 | 1.68 | 0.92 | 0.43 | 1.01 | 0.72 | 1.01 | 1.17 | 1.35 | 0.57 | 0.92 | 1.39 | 1.48 |
| Lower Saxony | 2.78 | 2.06 | 1.17 | 0.66 | 0.49 | 1.07 | 0.82 | 0.75 | 1.31 | 1.19 | 0.98 | 1.21 | 1.46 |
| North Rhine-Westphalia | 2.78 | 1.37 | 1.14 | 0.65 | 0.76 | 0.76 | 1.77 | 0.80 | 1.28 | 0.84 | 0.88 | 1.27 | 1.54 |
| Rhineland-Palatinate | 2.78 | 1.90 | 1.07 | 0.62 | 0.50 | 0.80 | 1.02 | 1.04 | 1.28 | 1.44 | 0.79 | 1.15 | 1.70 |
| Saarland | 2.78 | 1.52 | 1.83 | 0.40 | 0.52 | 0.59 | 1.29 | 0.91 | 1.42 | 1.25 | 0.71 | 1.28 | 2.03 |
| Saxony | 2.78 | 1.92 | 1.26 | 0.51 | 0.96 | 0.63 | 0.88 | 0.77 | 1.41 | 1.11 | 1.35 | 1.18 | 1.79 |
| Saxony-Anhalt | 2.78 | 2.00 | 0.94 | 0.69 | 0.47 | 0.69 | 2.01 | 0.66 | 1.26 | 0.90 | 1.05 | 1.30 | 1.15 |
| Schleswig-Holstein | 2.78 | 1.94 | 1.29 | 0.59 | 0.92 | 0.50 | 0.82 | 1.36 | 1.36 | 0.66 | 0.93 | 1.29 | 1.21 |
| Thuringia | 2.78 | 2.51 | 0.80 | 0.93 | 0.78 | 0.81 | 0.68 | 0.66 | 1.32 | 0.96 | 1.19 | 1.13 | 1.62 |
| Germany | 2.78 | 2.19 | 1.29 | 0.62 | 0.64 | 0.76 | 1.33 | 0.88 | 1.27 | 1.19 | 0.98 | 1.16 | 1.56 |

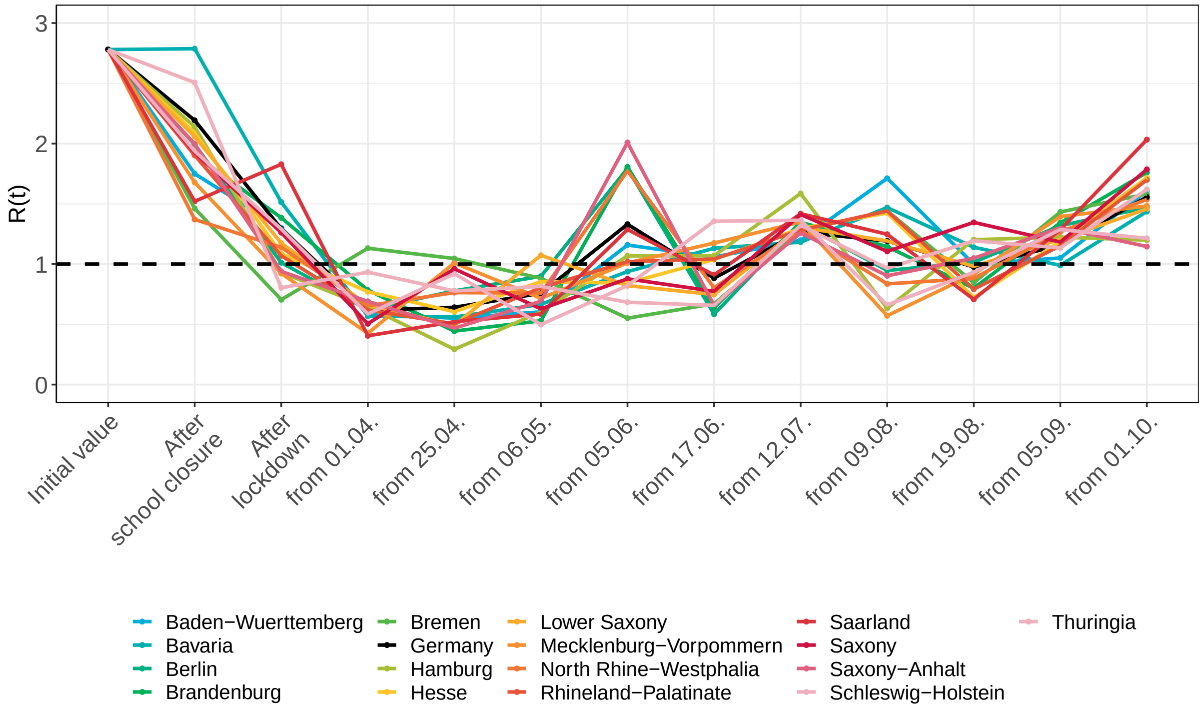



Figure 9: R(t) distribution before and after NPIs

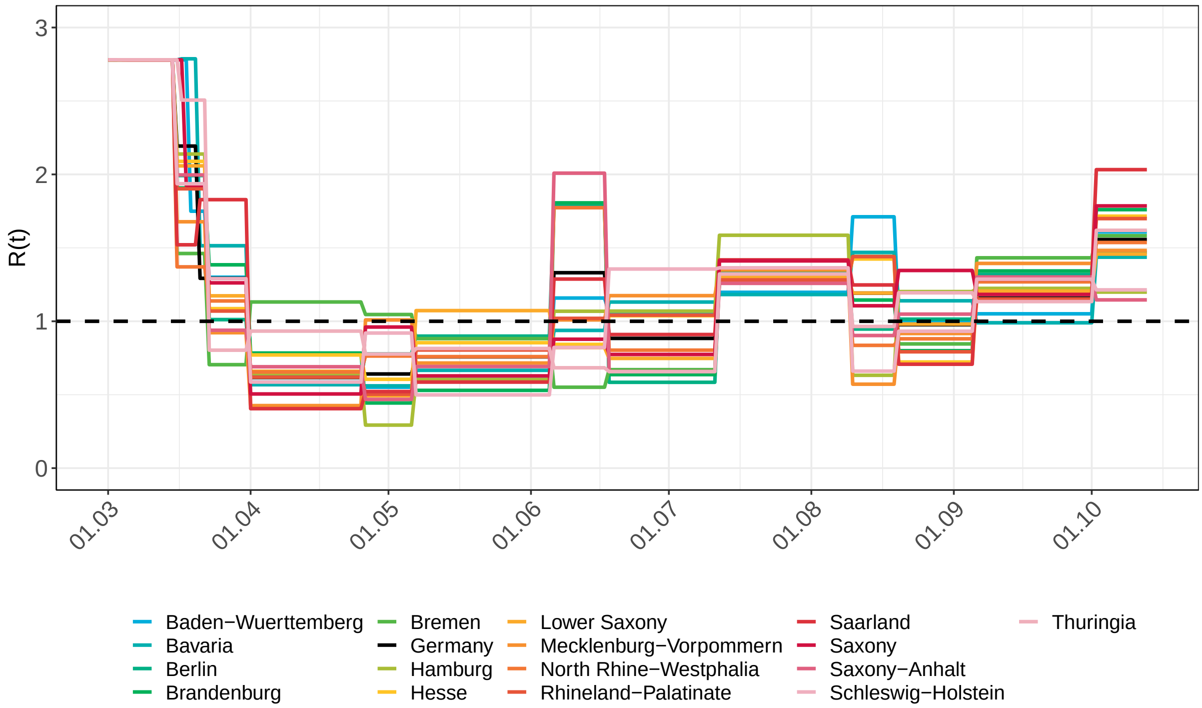



Figure 10: R(t) over time

### 1.6.3 Changes in hospitalization and inpatient mortality over time

The estimated hospitalization rate has decreased over time (figure [12]). At the beginning of the pandemic the rate was around 20% of all confirmed cases and it is currently below 10%. The hospitalization rate is strongly correlated with the age structure of infected COVID-19 population. Particularly the proportion of patients over 60 years of age determines the hospitalization rate. This percentage has decreased from over 35% initially to less than 10% in the meantime (figure [11]). With an increased number of infections among older patients, a rising hospitalization rate can be expected, even if the number of new infections remains the same. Inpatient mortality rates (normal ward, ICU ventilated and non-ventilated) decrease significantly over time, similar to the hospitalization rate (figure [12]). This can also be attributed to the decreasing age of the infected patients. In this case, an increase in hospital mortality can also be expected if a higher number of elderly patients become infected again

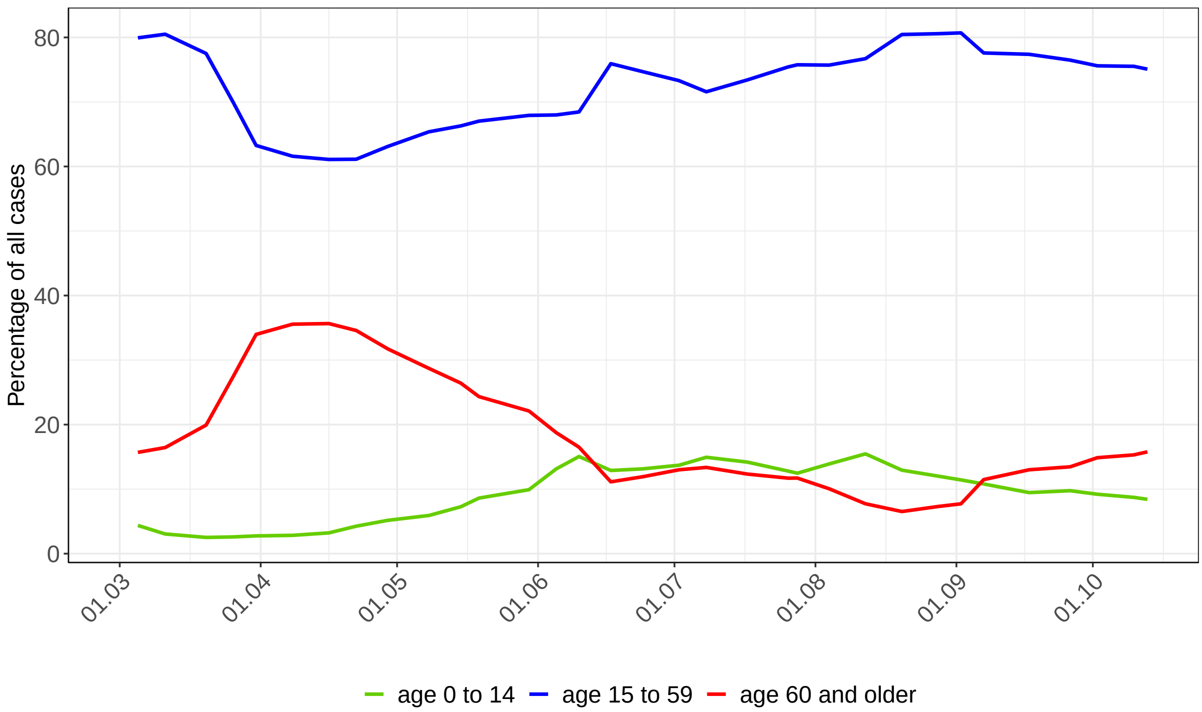



Figure 11: Age distribution of COVID-19 cases over time in Germany

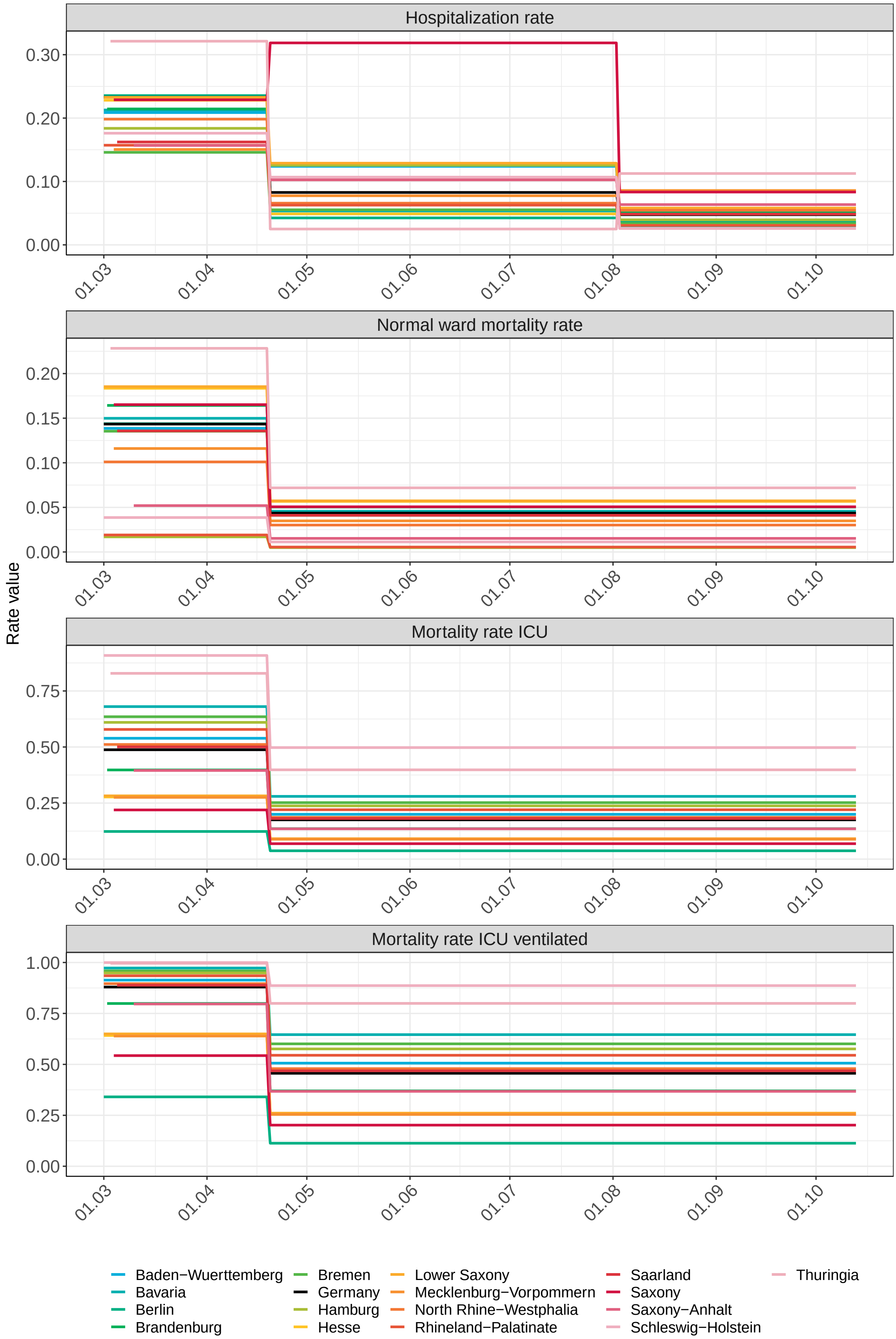



Figure 12: Hospitalization and mortality rates over time

# 2 Baden-Wuerttemberg

## 2.1 Model description

Fig. 13 depicts the results of the modeling (lines) compared to the observed data (points) for Baden-Wuerttemberg on a linear (A) and semi-logarithmic (B) scale.

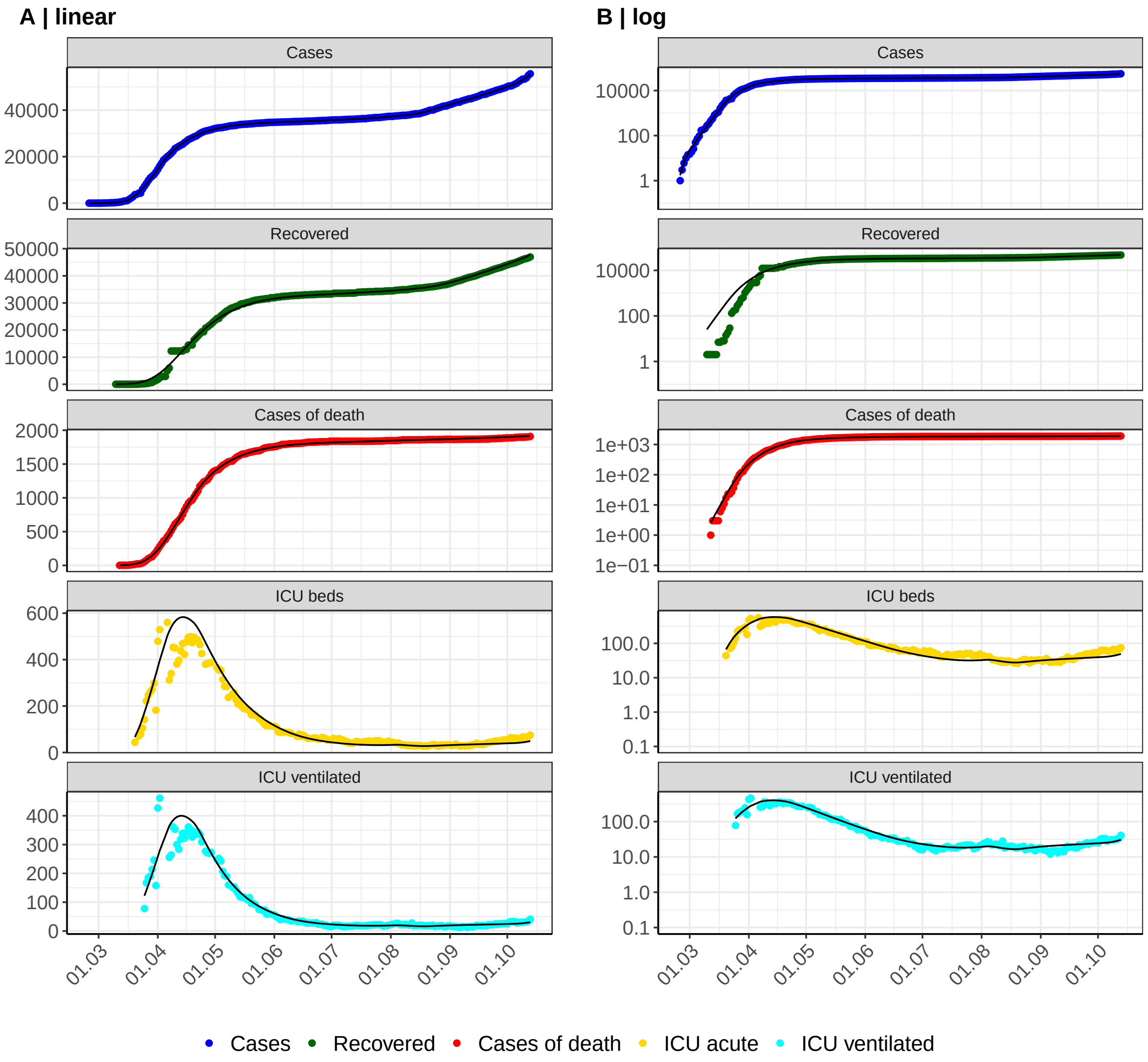



Figure 13: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Baden-Wuerttemberg. Points: reported data; lines: model description.

Fig. 14 shows the goodness-of-fit for Baden-Wuerttemberg. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

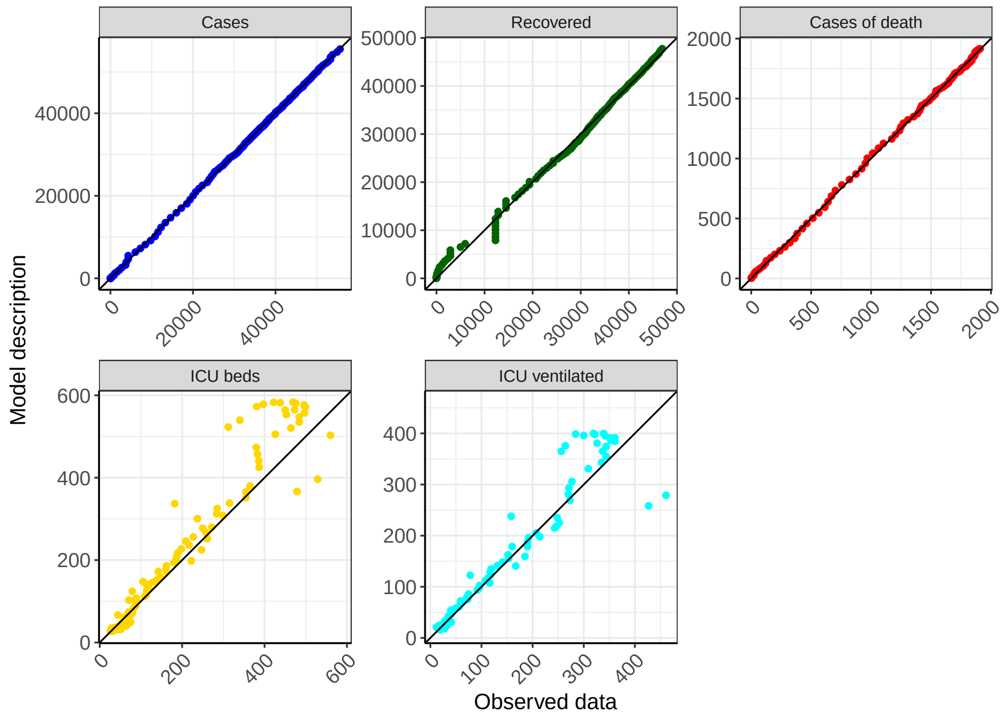



Figure 14: Goodness-of-fit plots for Baden-Wuerttemberg. Lines: lines of identity.

Fig. 15 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Baden-Wuerttemberg (red line) in comparison with the other federal states (grey lines).

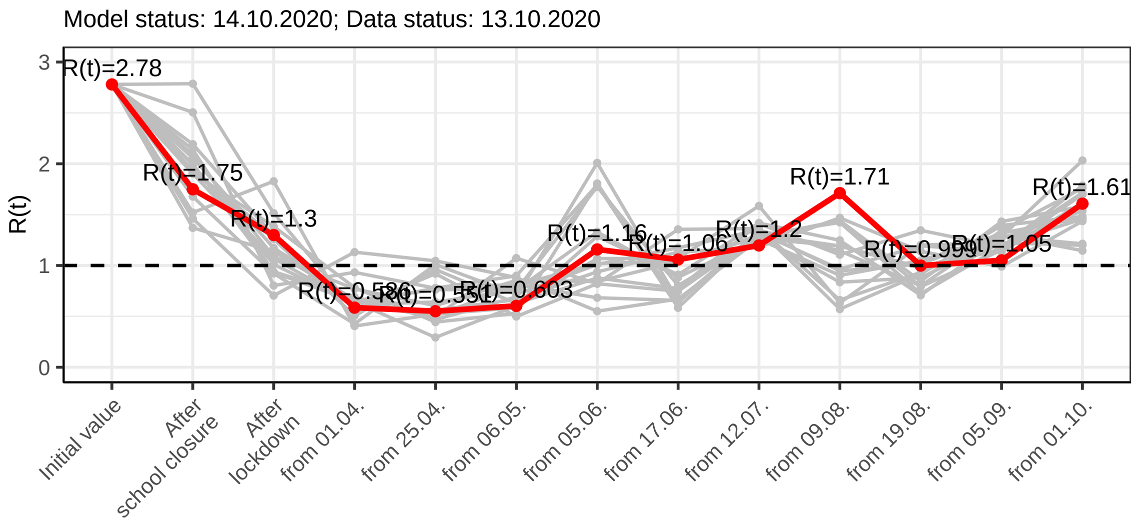



Figure 15: R(t) values before and after the NPIs for Baden-Wuerttemberg

Fig. 16 shows the R(t) estimated value for Baden-Wuerttemberg (red line) over time in comparison with the other federal states (grey lines).

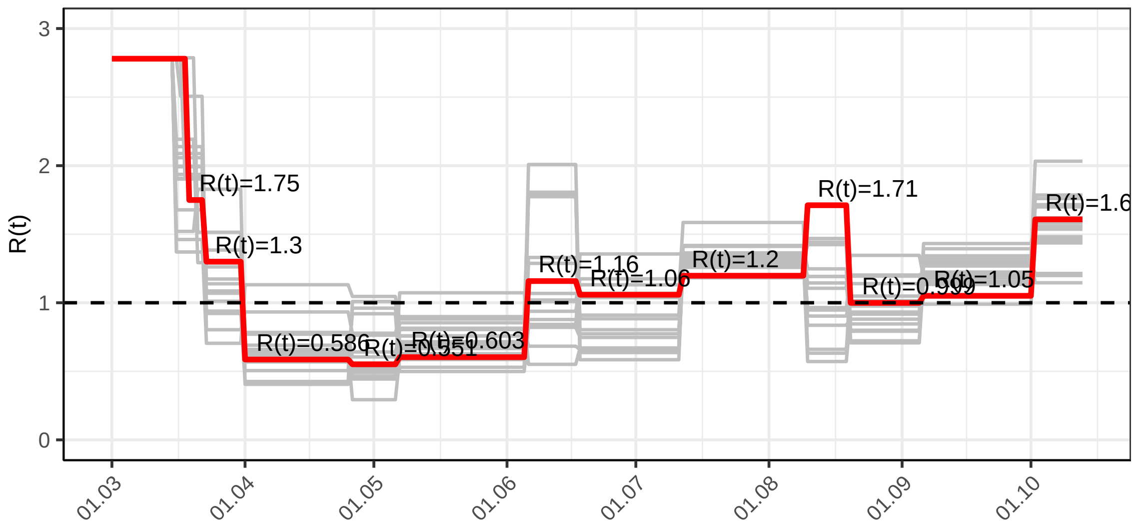



Figure 16: R(t) values over time for Baden-Wuerttemberg

Fig. 17 shows the changes in hospitalization and death rates for Baden-Wuerttemberg (red line) over time compared to the other states (grey lines).

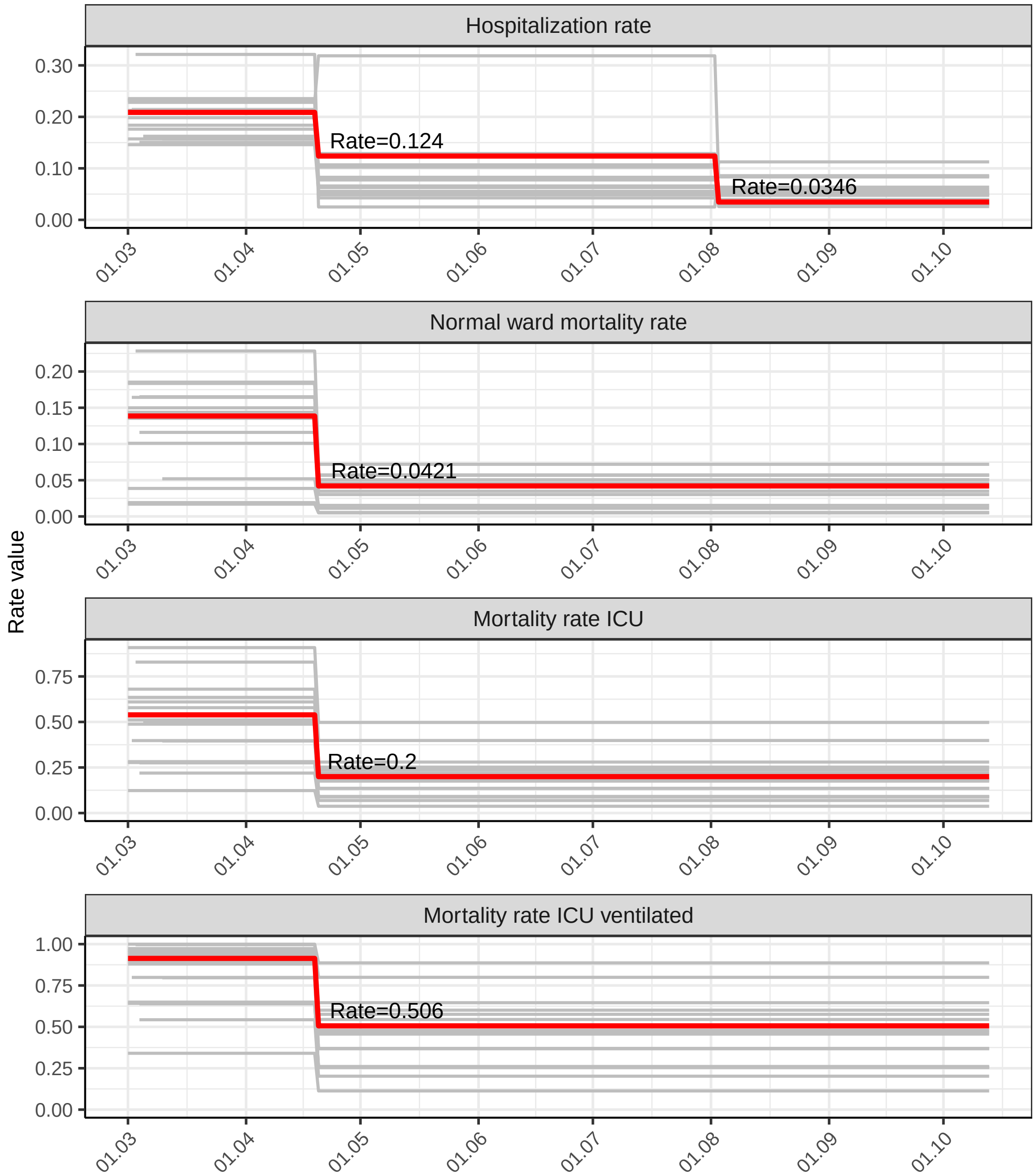



Figure 17: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Baden-Wuerttemberg

## 2.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.61)

Fig.18 and 19 depict the the model predictions for the next 4 weeks for Baden-Wuerttemberg on a linear (18) and a semi-logarithmic (19) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

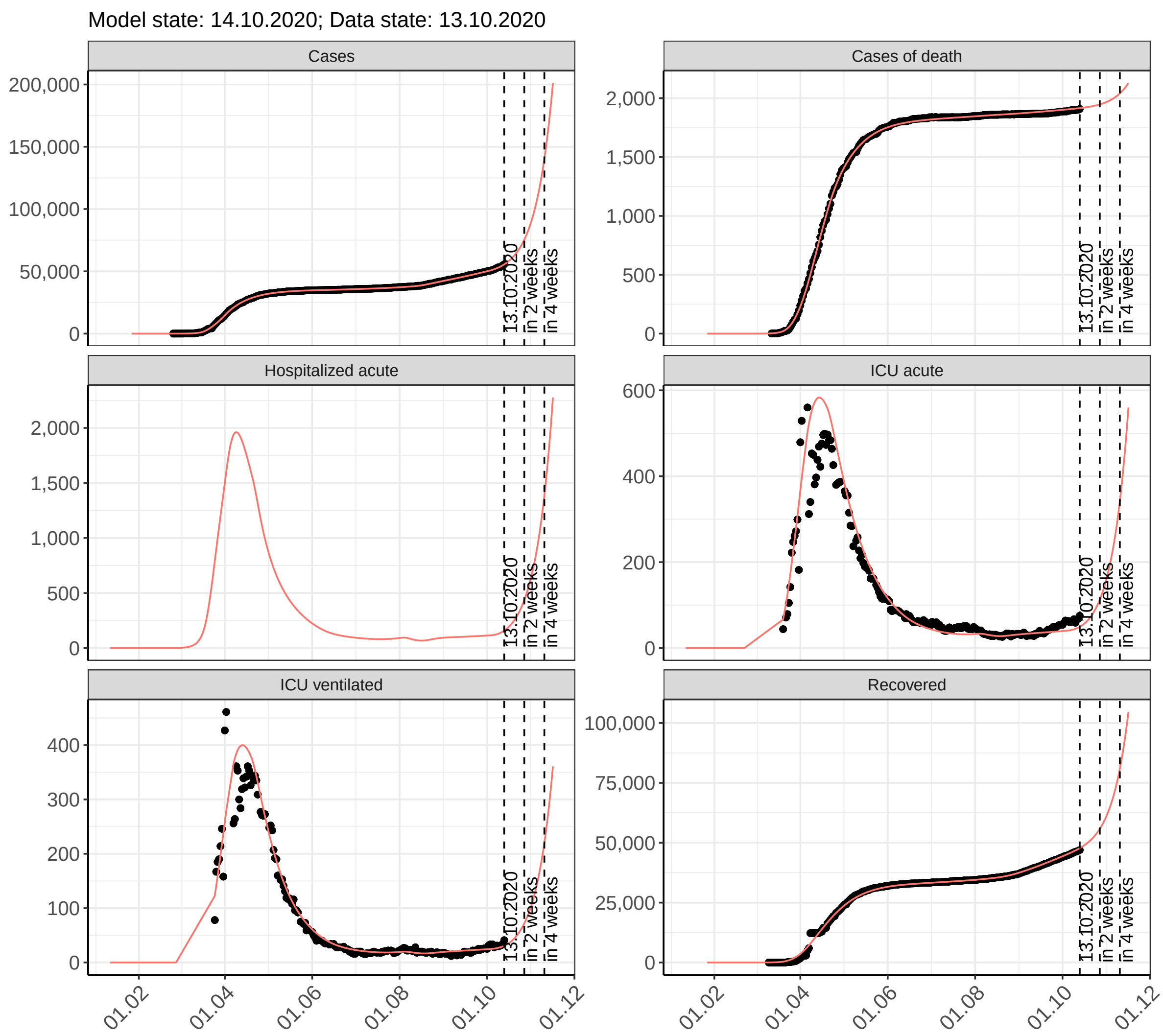



Figure 18: Representation of the model predictions for Baden-Wuerttemberg for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

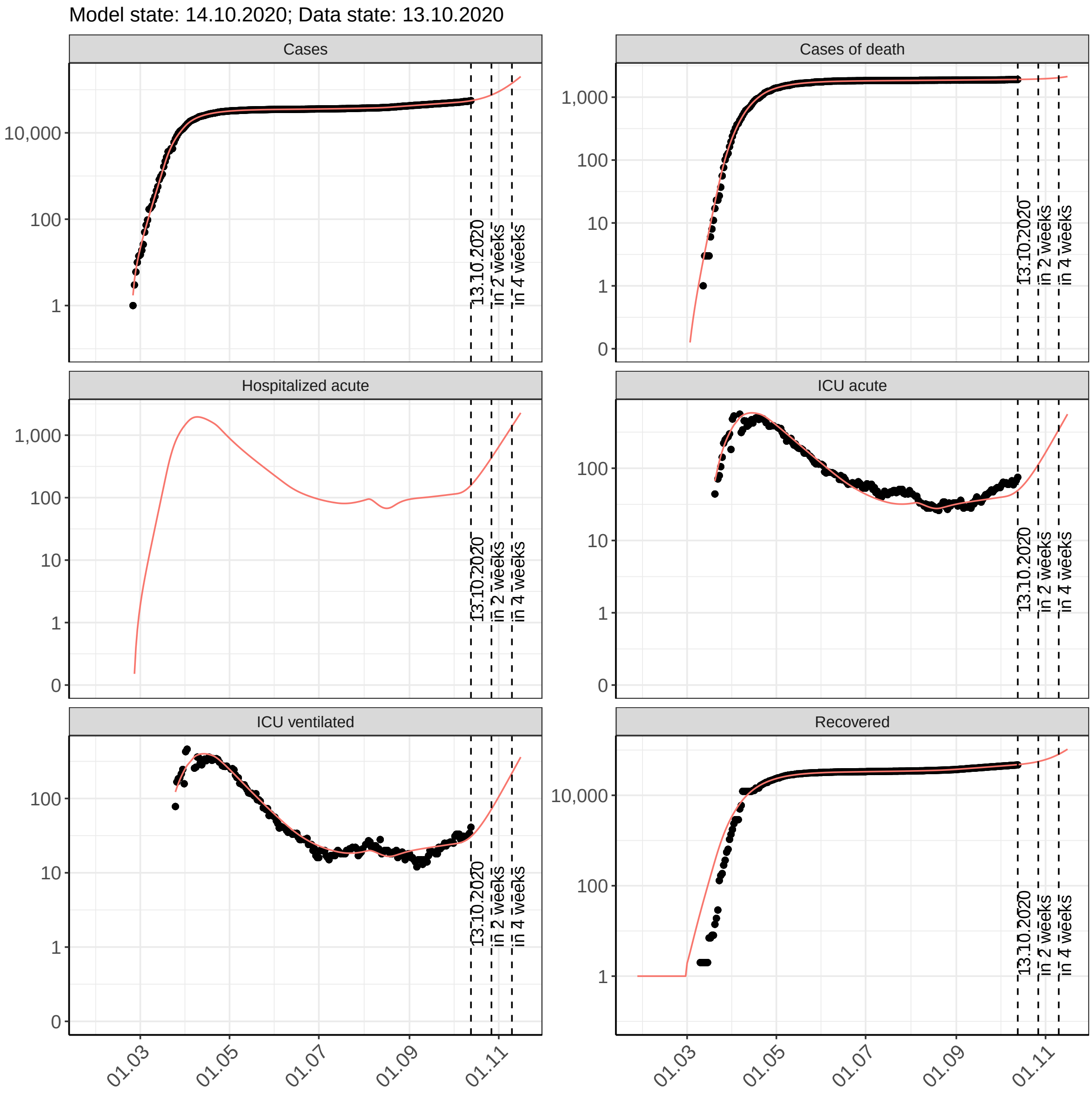



Figure 19: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Baden-Wuerttemberg for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.20 and 21 represent the model prediction for the next 8 weeks for Baden-Wuerttemberg on a linear (20) and a semi-logarithmic (21) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

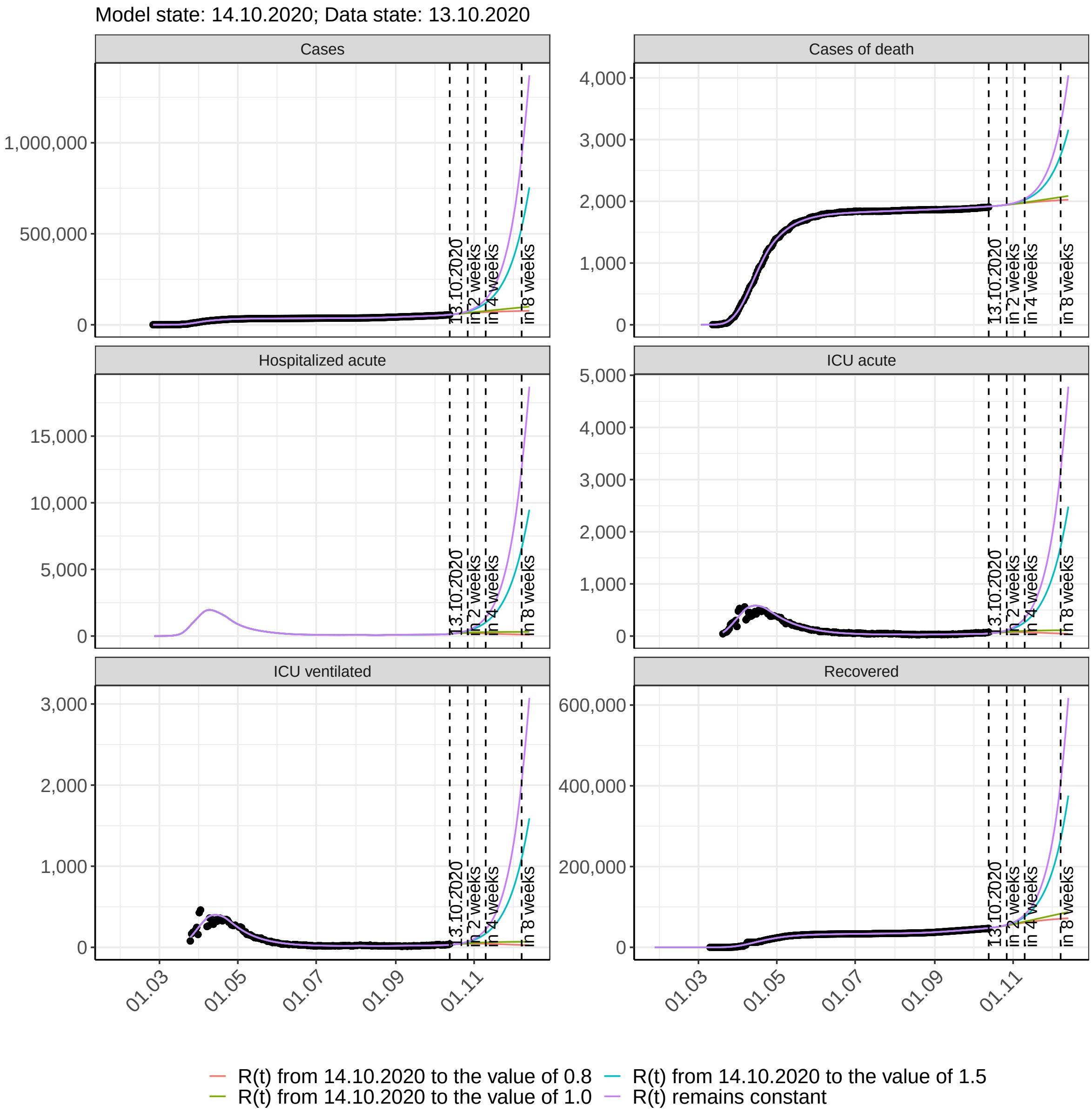



Figure 20: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Baden-Wuerttemberg assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

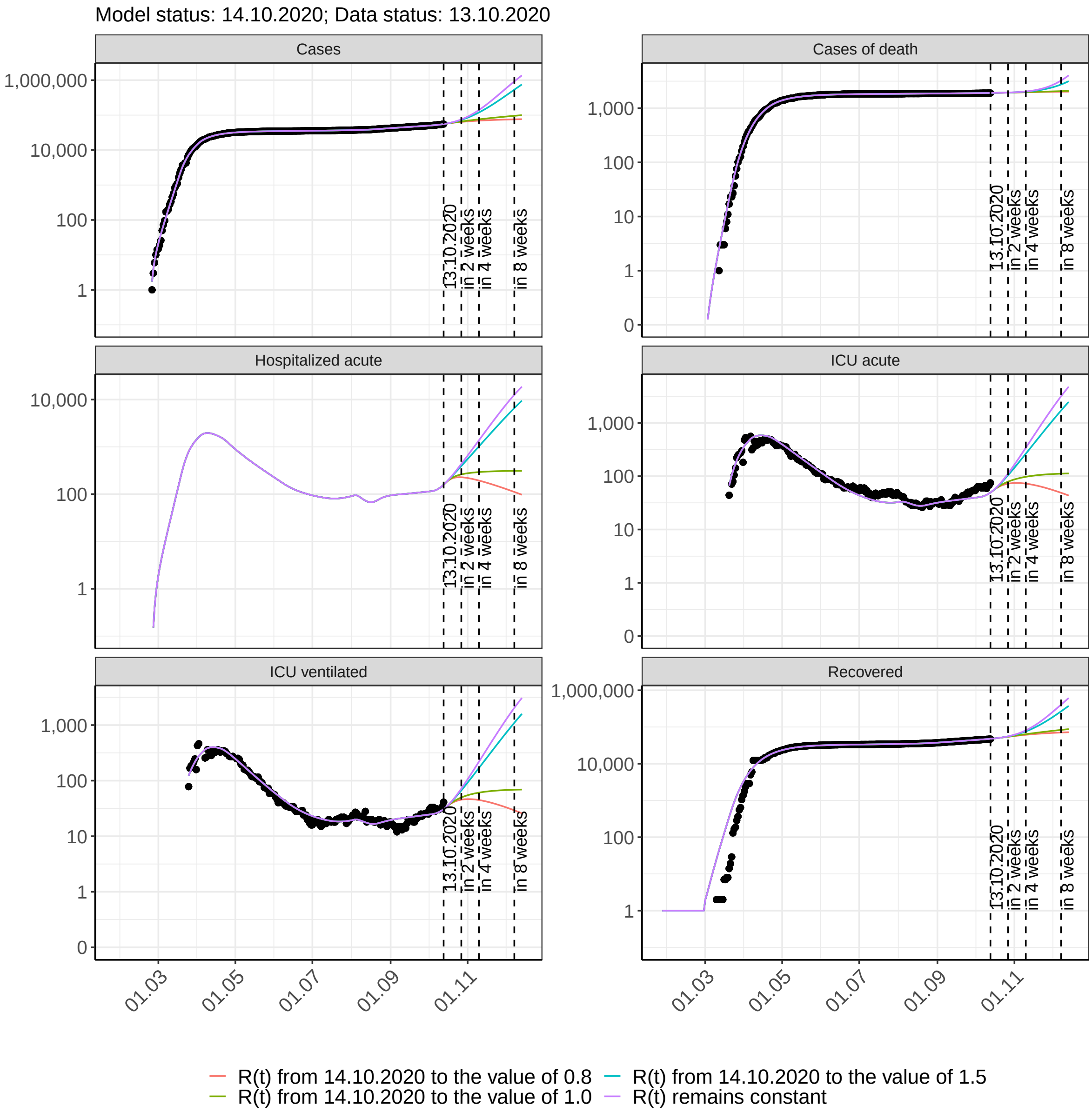



Figure 21: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Baden-Wuerttemberg assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

**Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020**

Fig. 22 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

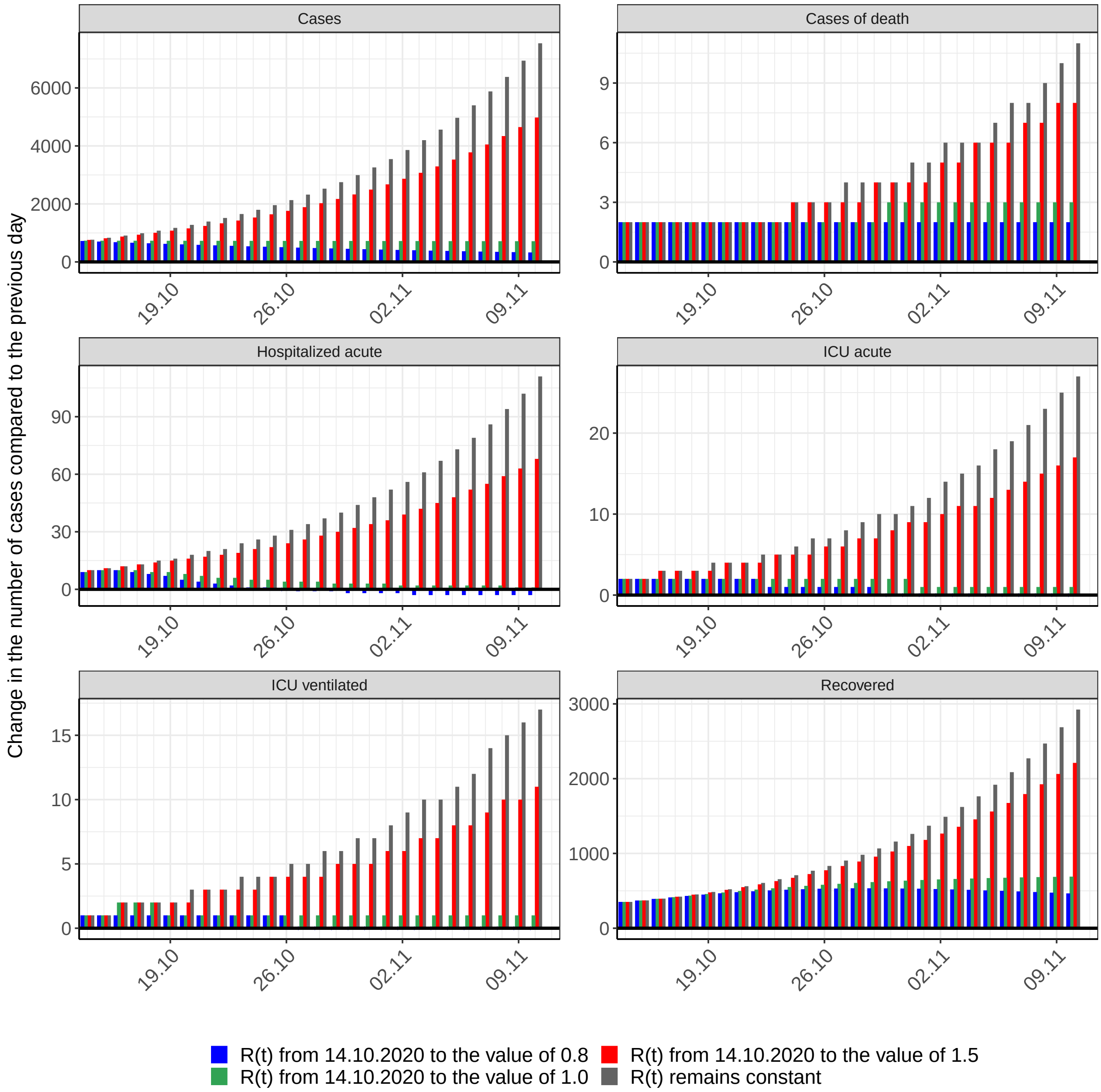



Figure 22: Simulation of daily new cases for the next 4 weeks - Baden-Wuerttemberg

# 3 Bavaria

## 3.1 Model description

Fig. 23 depicts the results of the modeling (lines) compared to the observed data (points) for Bavaria on a linear (A) and semi-logarithmic (B) scale.

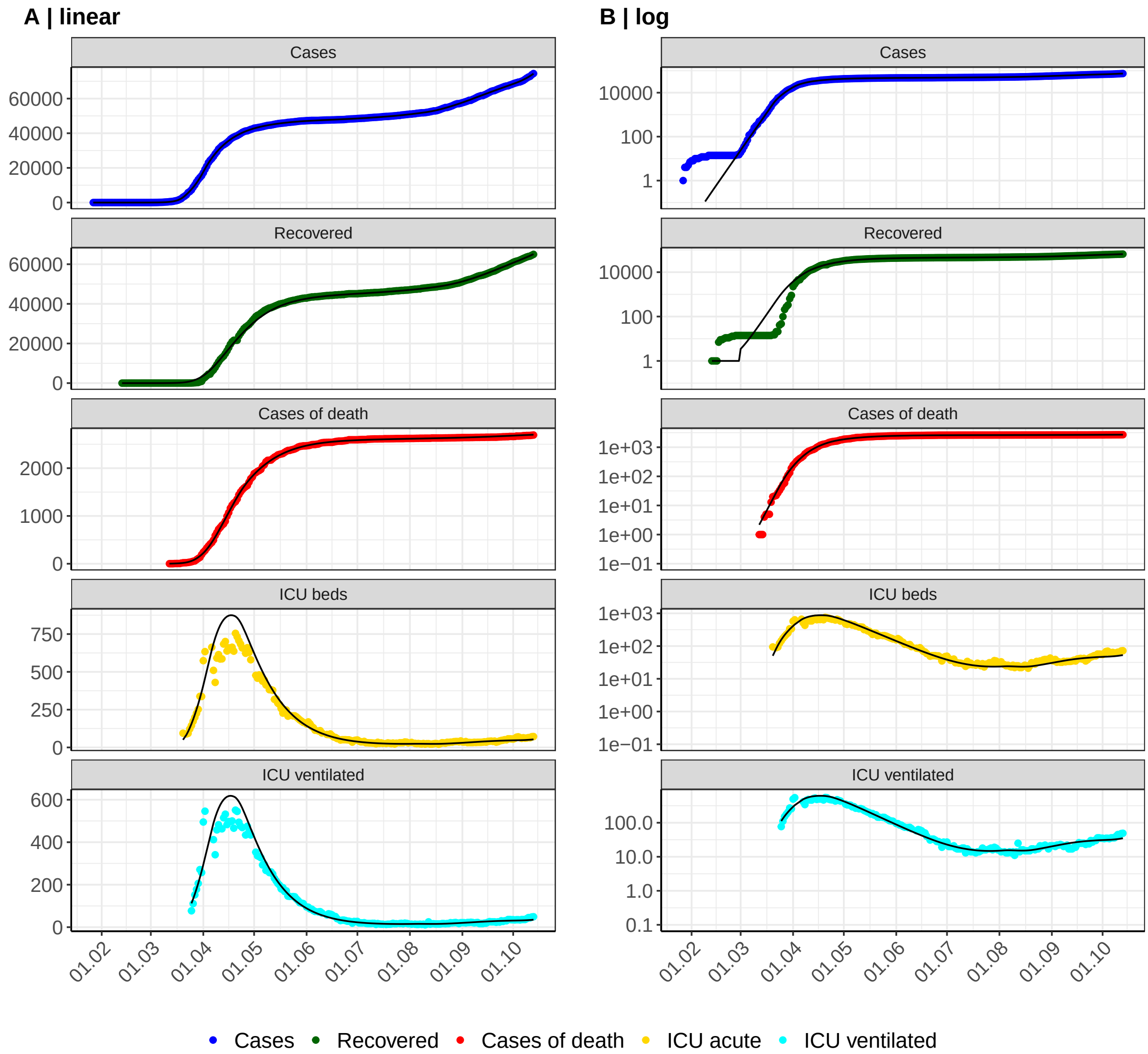



Figure 23: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Bavaria. Points: reported data; lines: model description.

Fig. 24 shows the goodness-of-fit for Bavaria. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

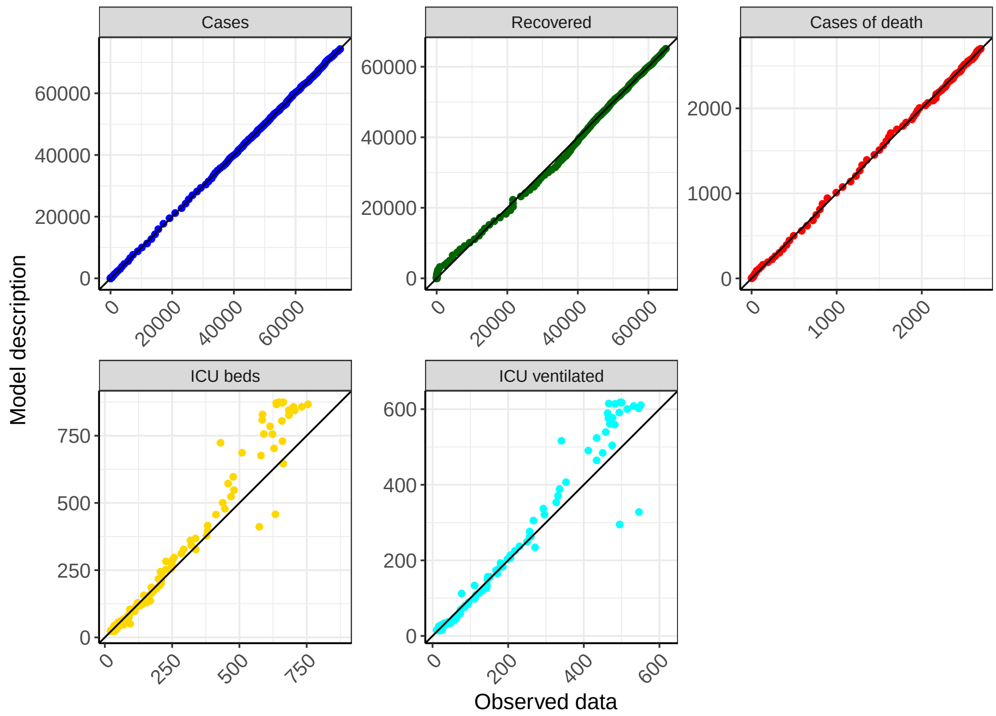



Figure 24: Goodness-of-fit plots for Bavaria. Lines: lines of identity.

Fig. 25 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Bavaria (red line) in comparison with the other federal states (grey lines).

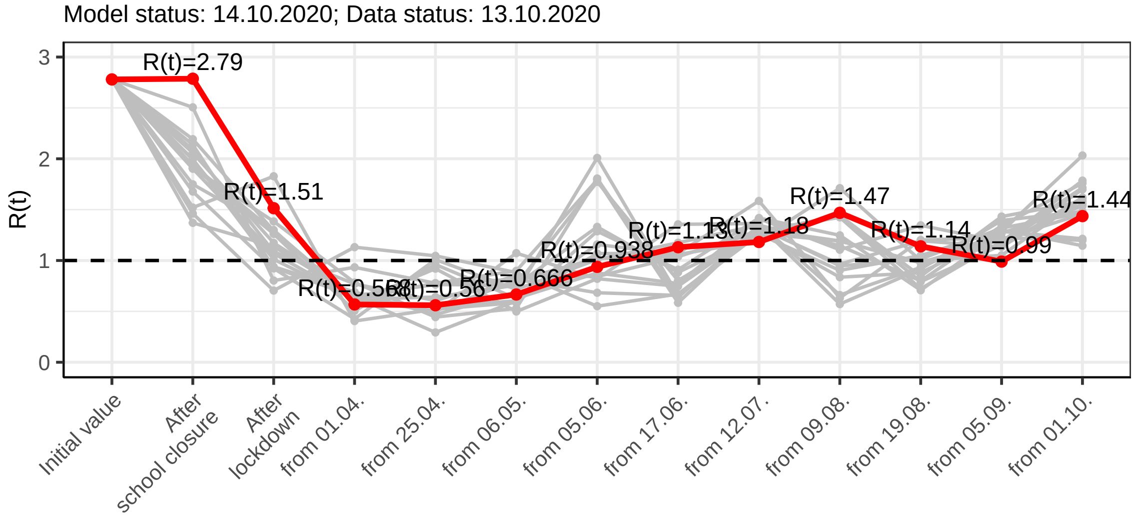



Figure 25: R(t) values before and after the NPIs for Bavaria

Fig. 26 shows the R(t) estimated value for Bavaria (red line) over time in comparison with the other federal states (grey lines).

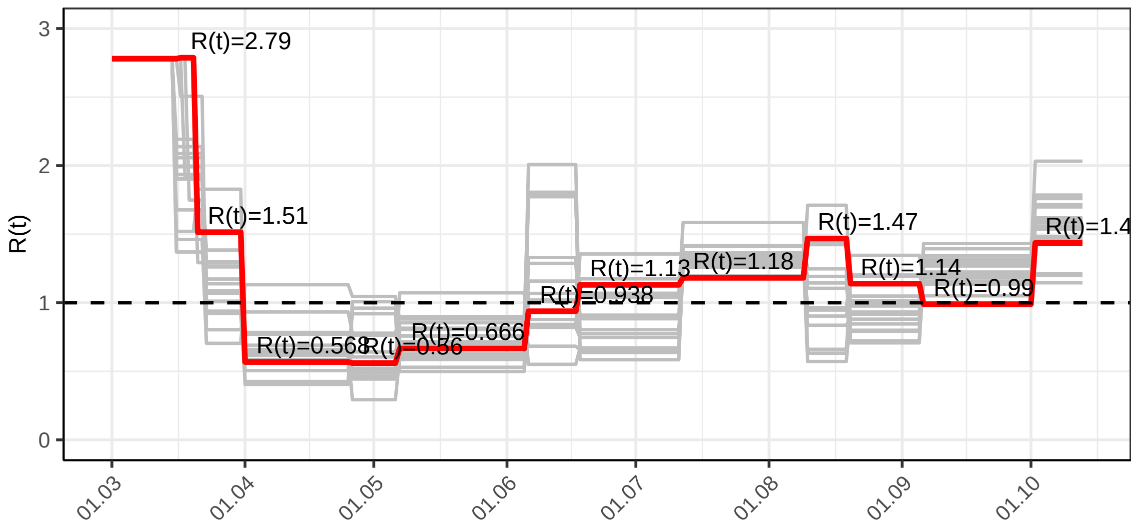



Figure 26: R(t) values over time for Bavaria

Fig. 27 shows the changes in hospitalization and death rates for Bavaria (red line) over time compared to the other states (grey lines).

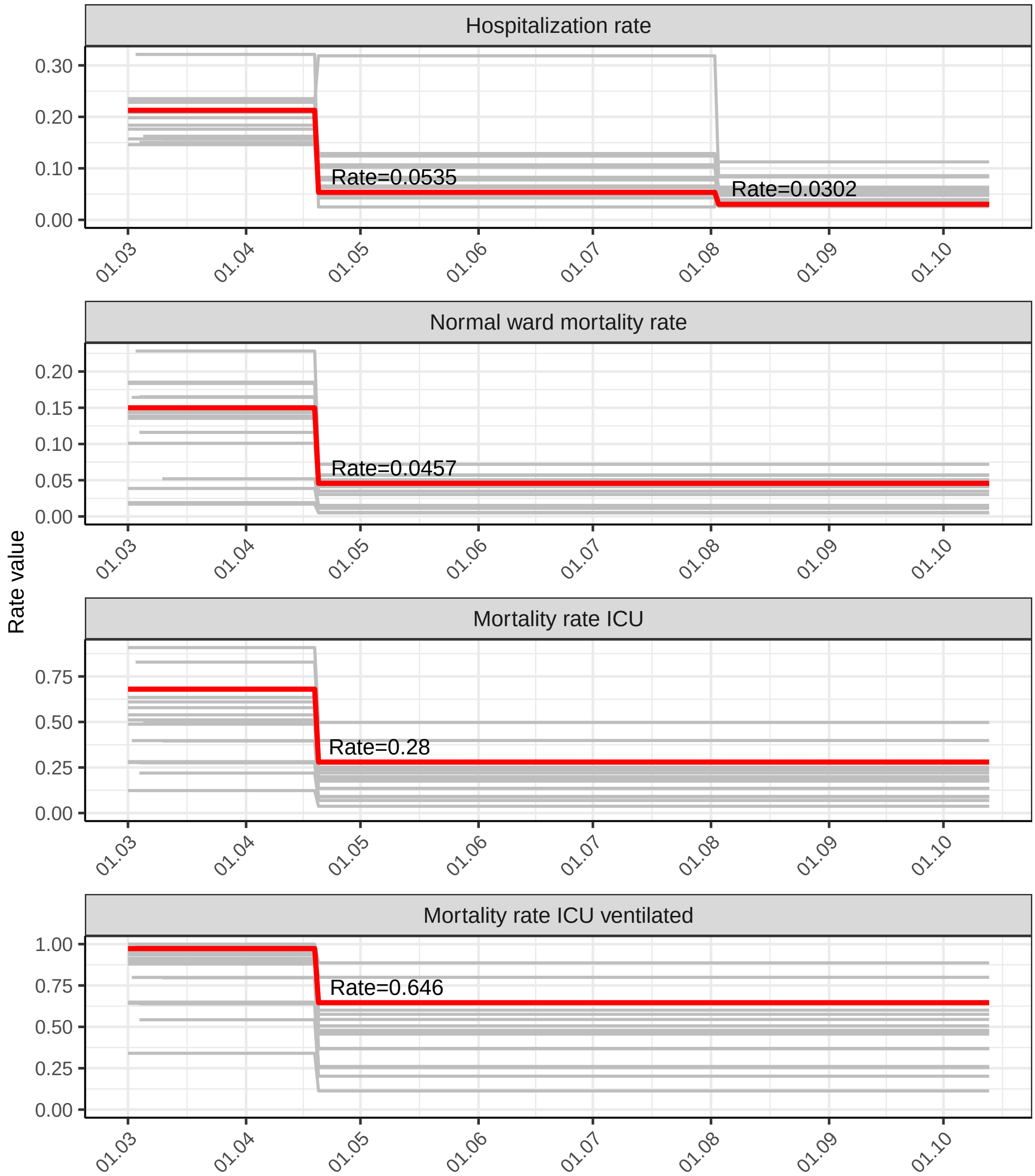



Figure 27: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Bavaria

## 3.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.44)

Fig.28 and 29 depict the the model predictions for the next 4 weeks for Bavaria on a linear (28) and a semi-logarithmic (29) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

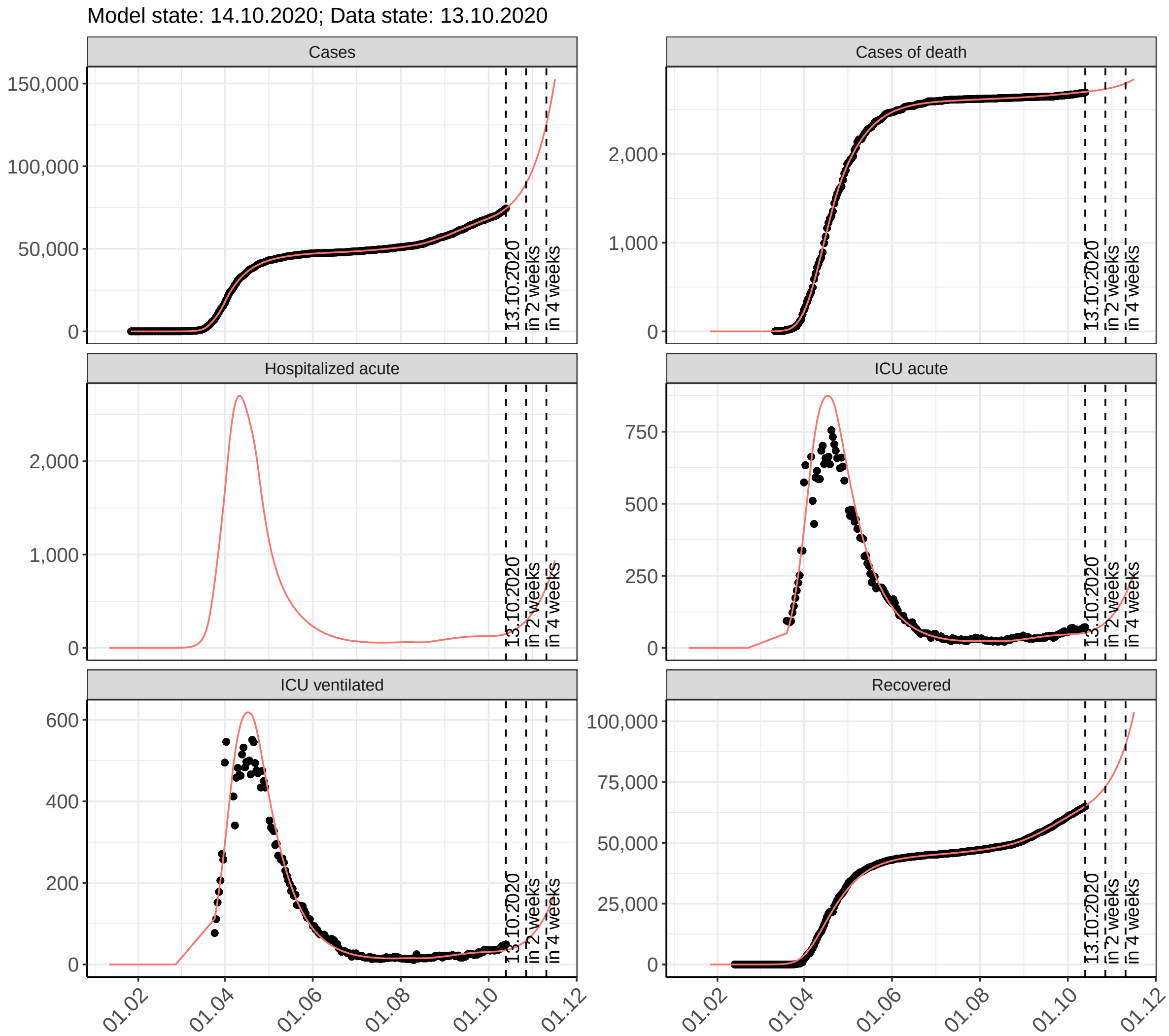



Figure 28: Representation of the model predictions for Bavaria for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

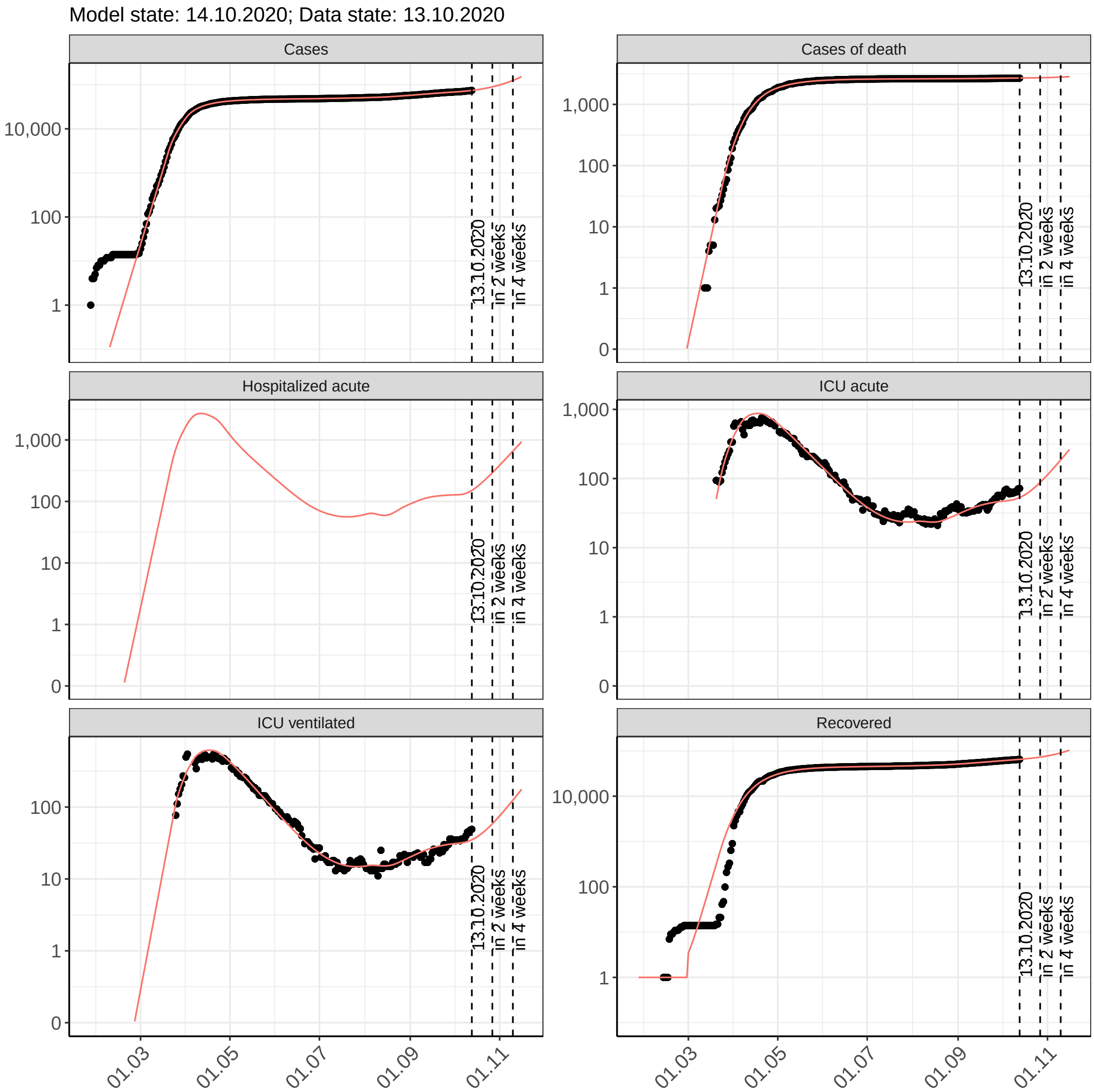



Figure 29: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Bavaria for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.30 and 31 represent the model prediction for the next 8 weeks for Bavaria on a linear (30) and a semi-logarithmic (31) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

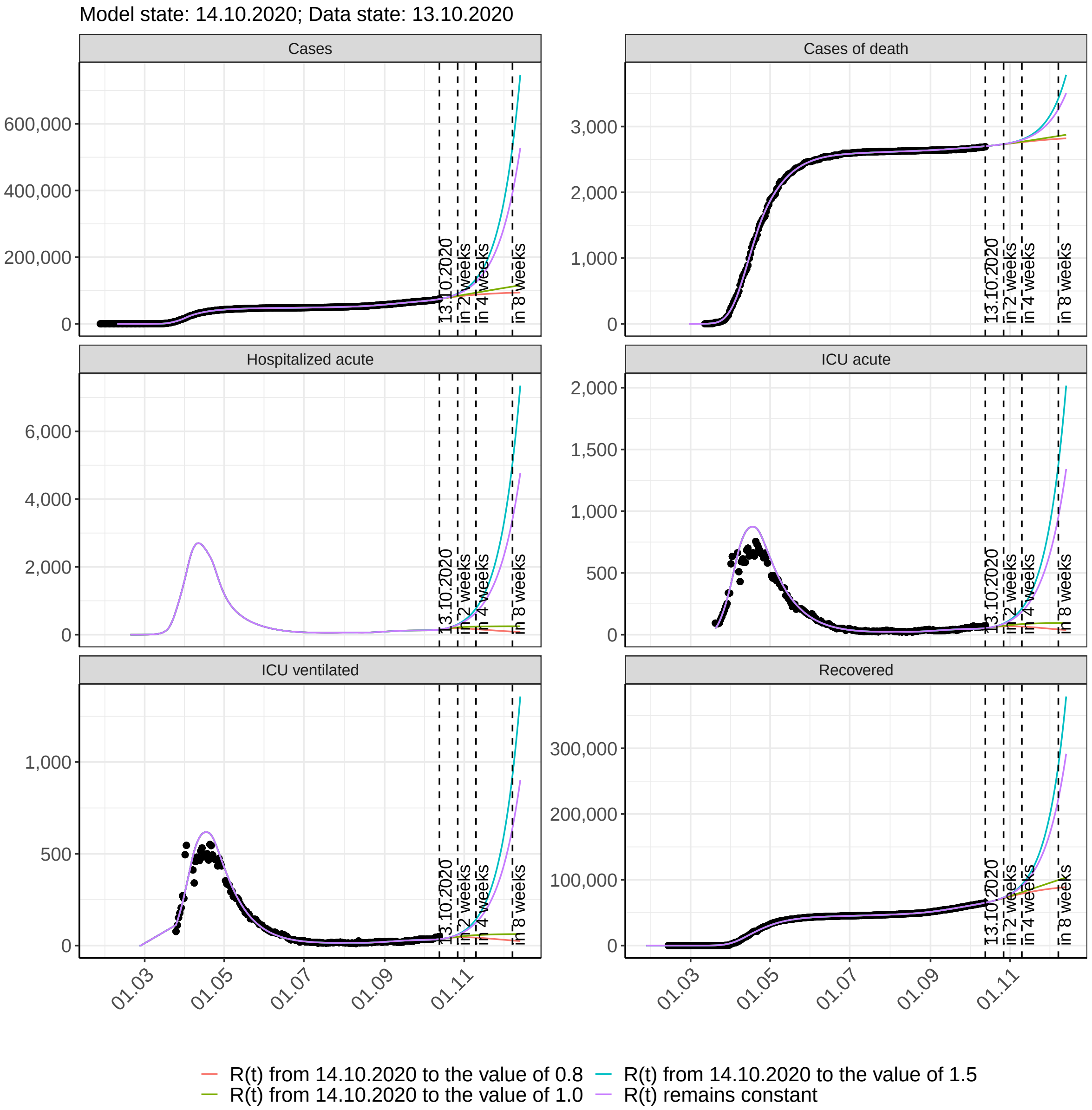



Figure 30: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Bavaria assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

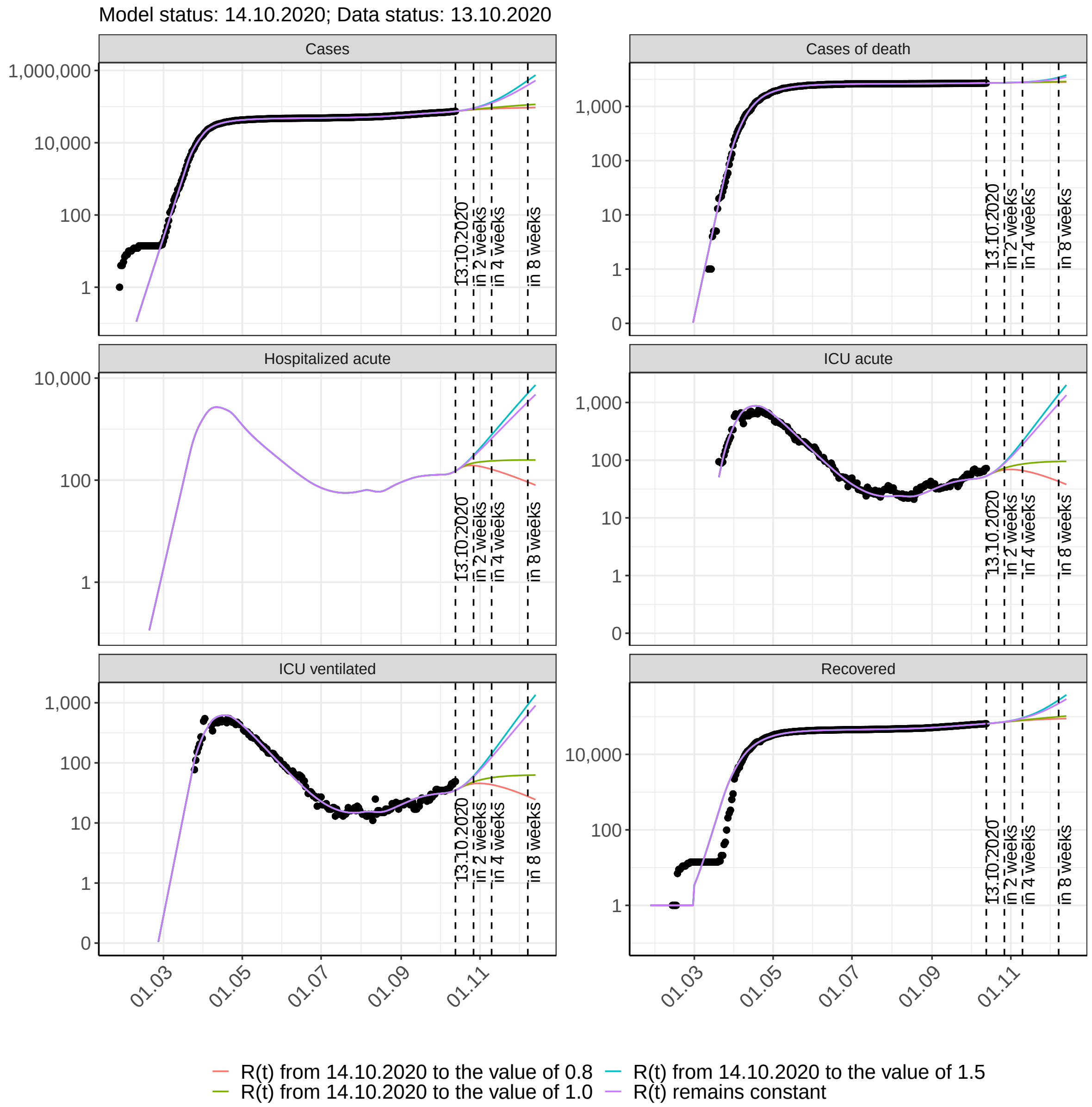



Figure 31: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Bavaria assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

**Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020**

Fig. 32 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

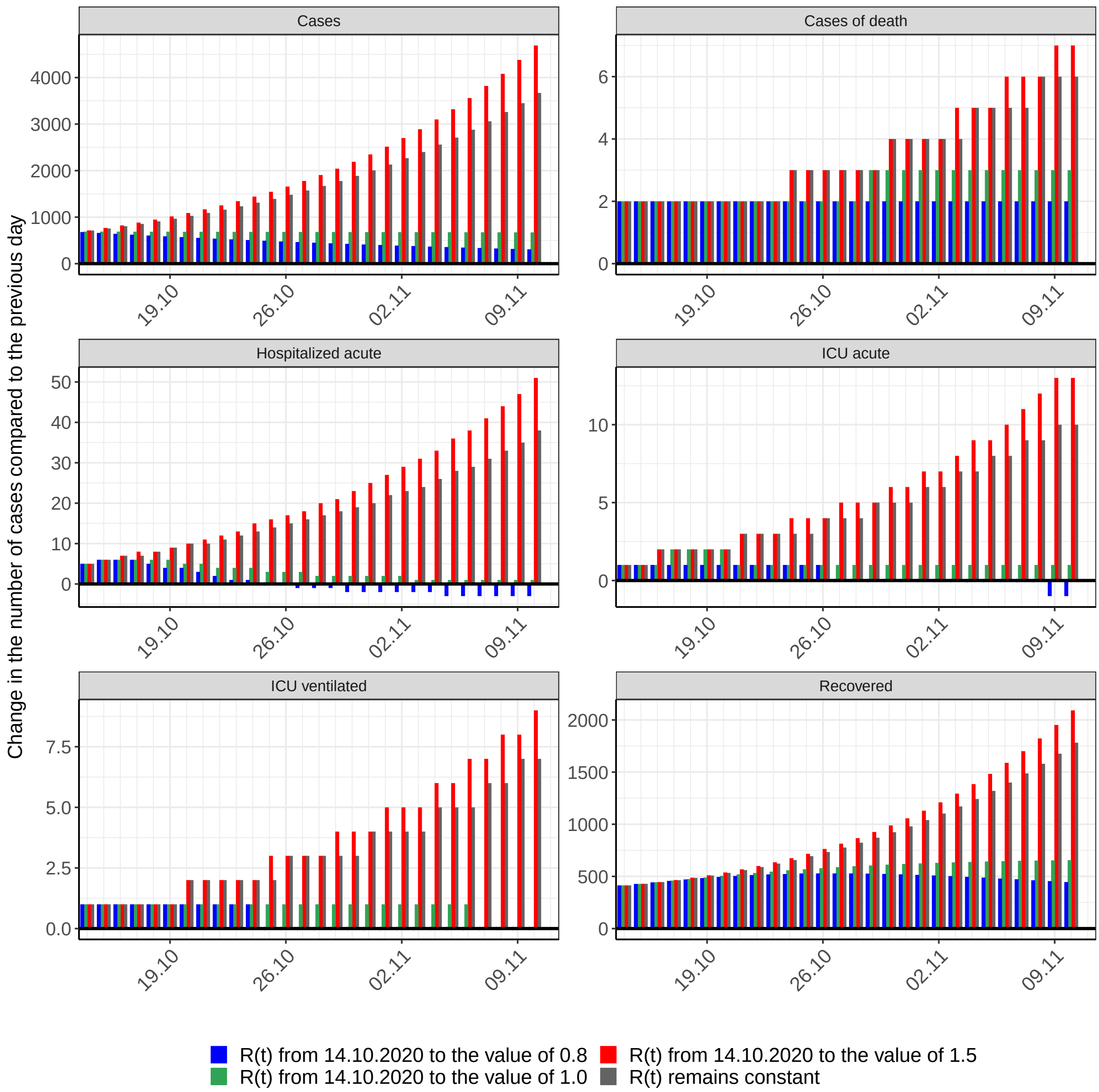



Figure 32: Simulation of daily new cases for the next 4 weeks - Bavaria

# 4 Berlin

## 4.1 Model description

Fig. 33 depicts the results of the modeling (lines) compared to the observed data (points) for Berlin on a linear (A) and semi-logarithmic (B) scale.

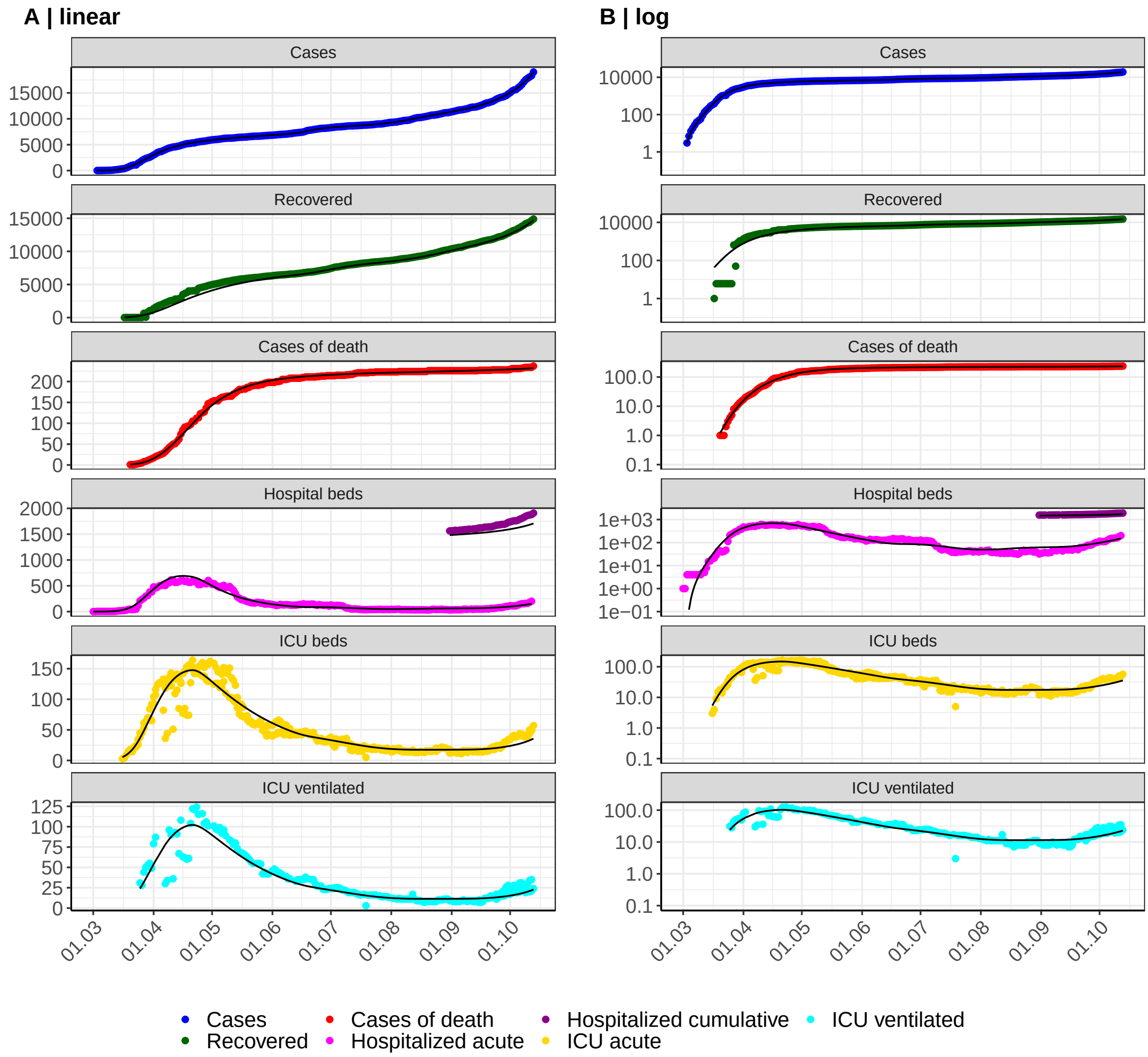



Figure 33: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Berlin. Points: reported data; lines: model description.

Fig. 34 shows the goodness-of-fit for Berlin. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

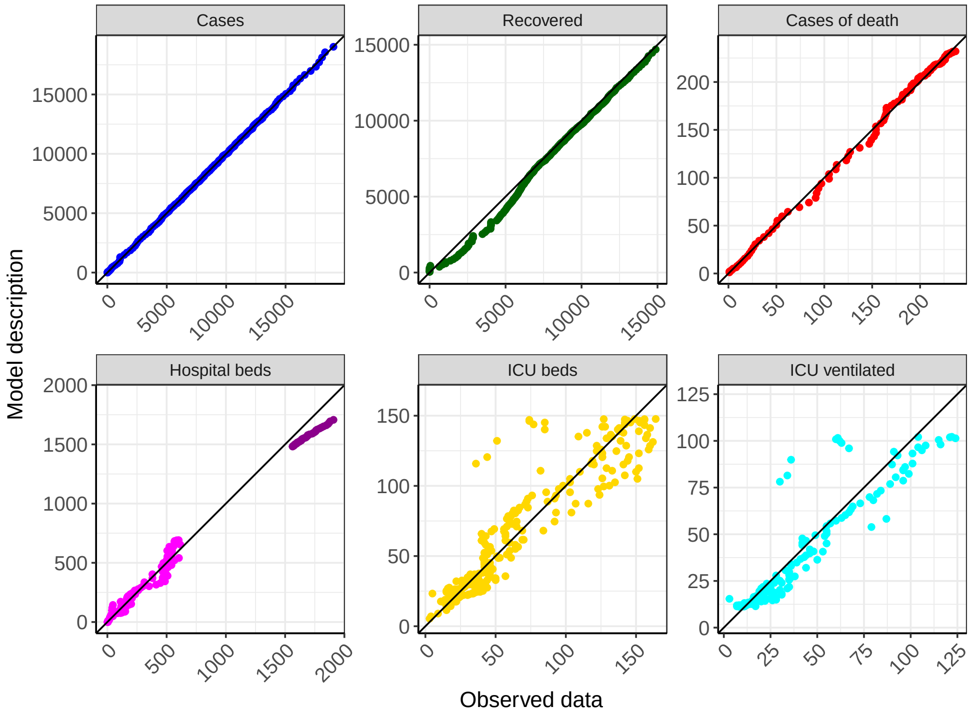



Figure 34: Goodness-of-fit plots for Berlin. Lines: lines of identity.

Fig. 35 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Berlin (red line) in comparison with the other federal states (grey lines).

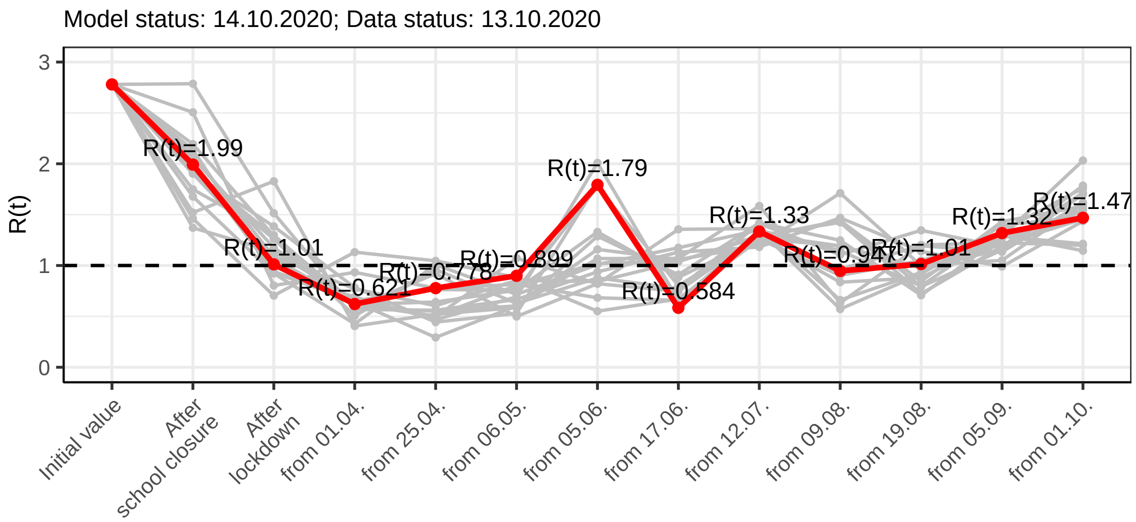



Figure 35: R(t) values before and after the NPIs for Berlin

Fig. 36 shows the R(t) estimated value for Berlin (red line) over time in comparison with the other federal states (grey lines).

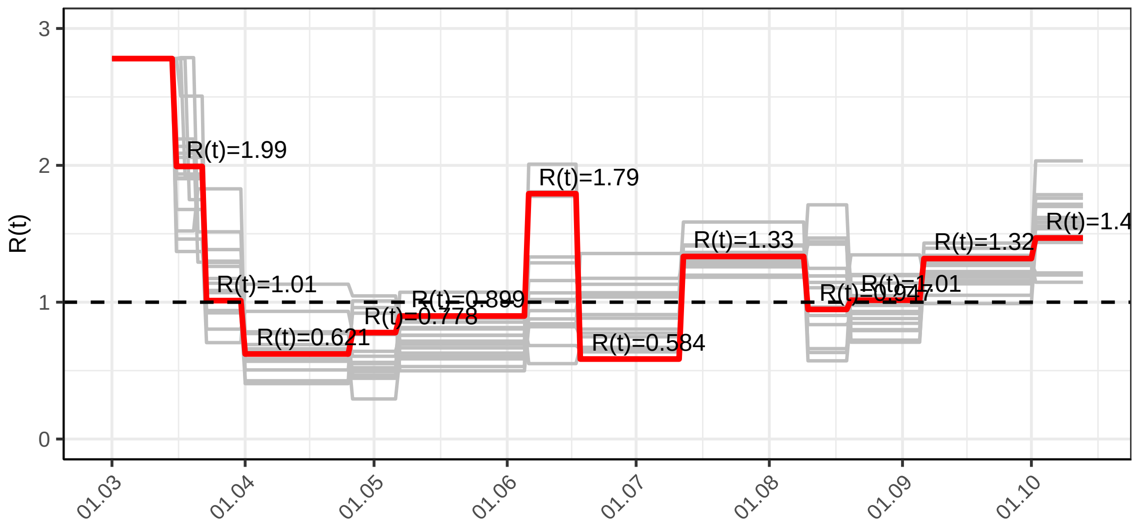



Figure 36: R(t) values over time for Berlin

Fig. 37 shows the changes in hospitalization and death rates for Berlin (red line) over time compared to the other states (grey lines).

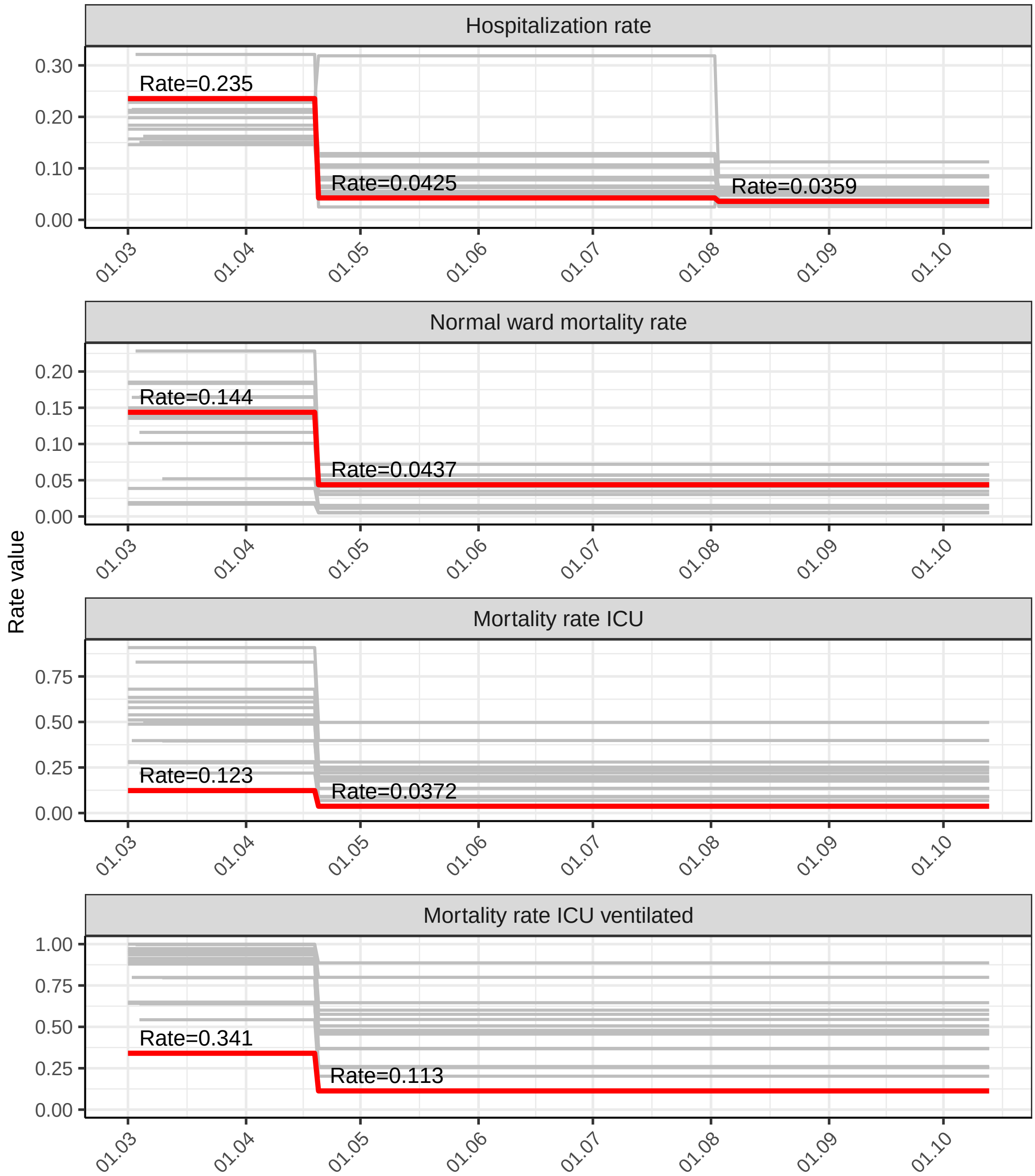



Figure 37: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Berlin

## 4.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.47)

Fig.38 and 39 depict the the model predictions for the next 4 weeks for Berlin on a linear (38) and a semi-logarithmic (39) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

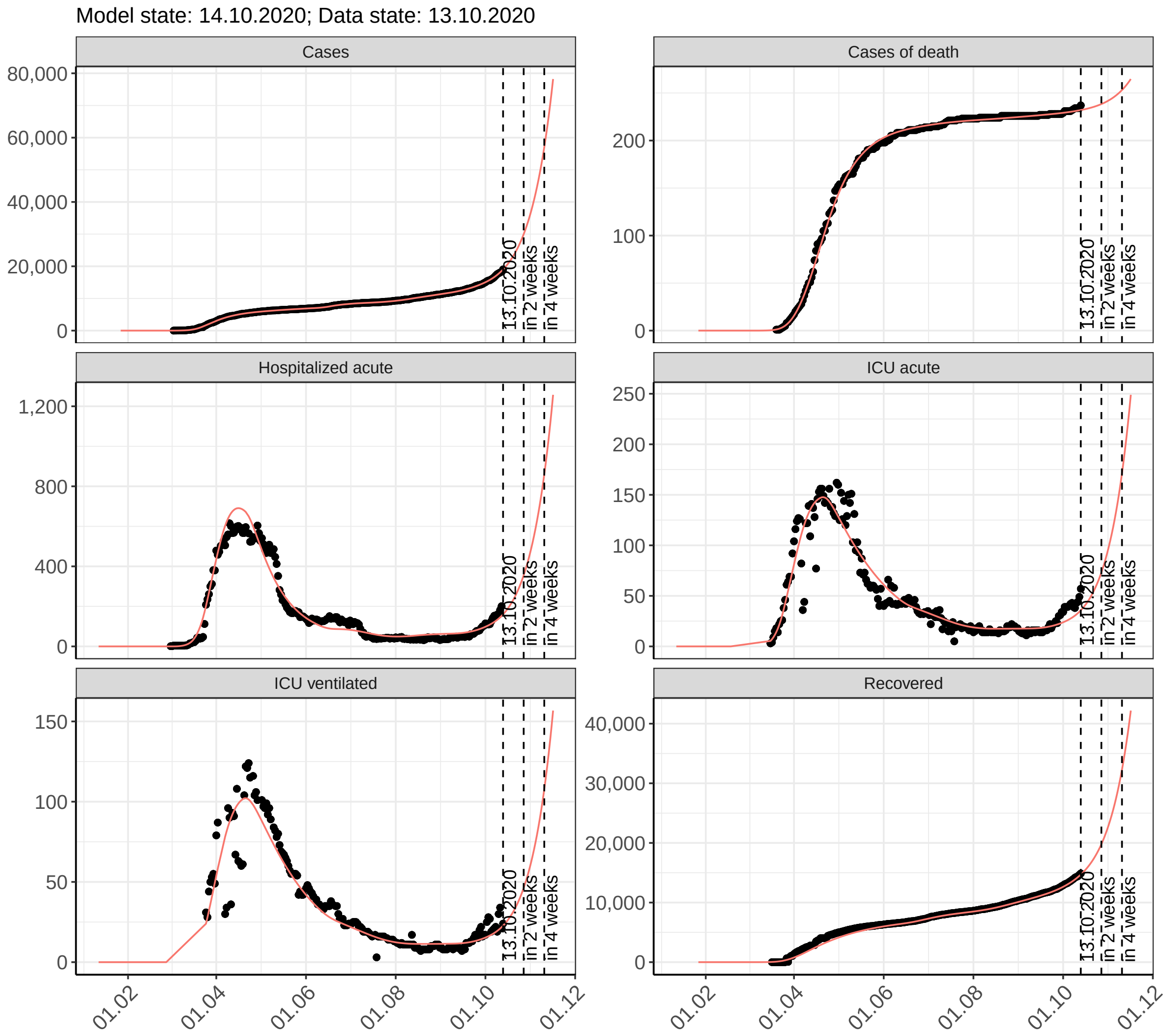



Figure 38: Representation of the model predictions for Berlin for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

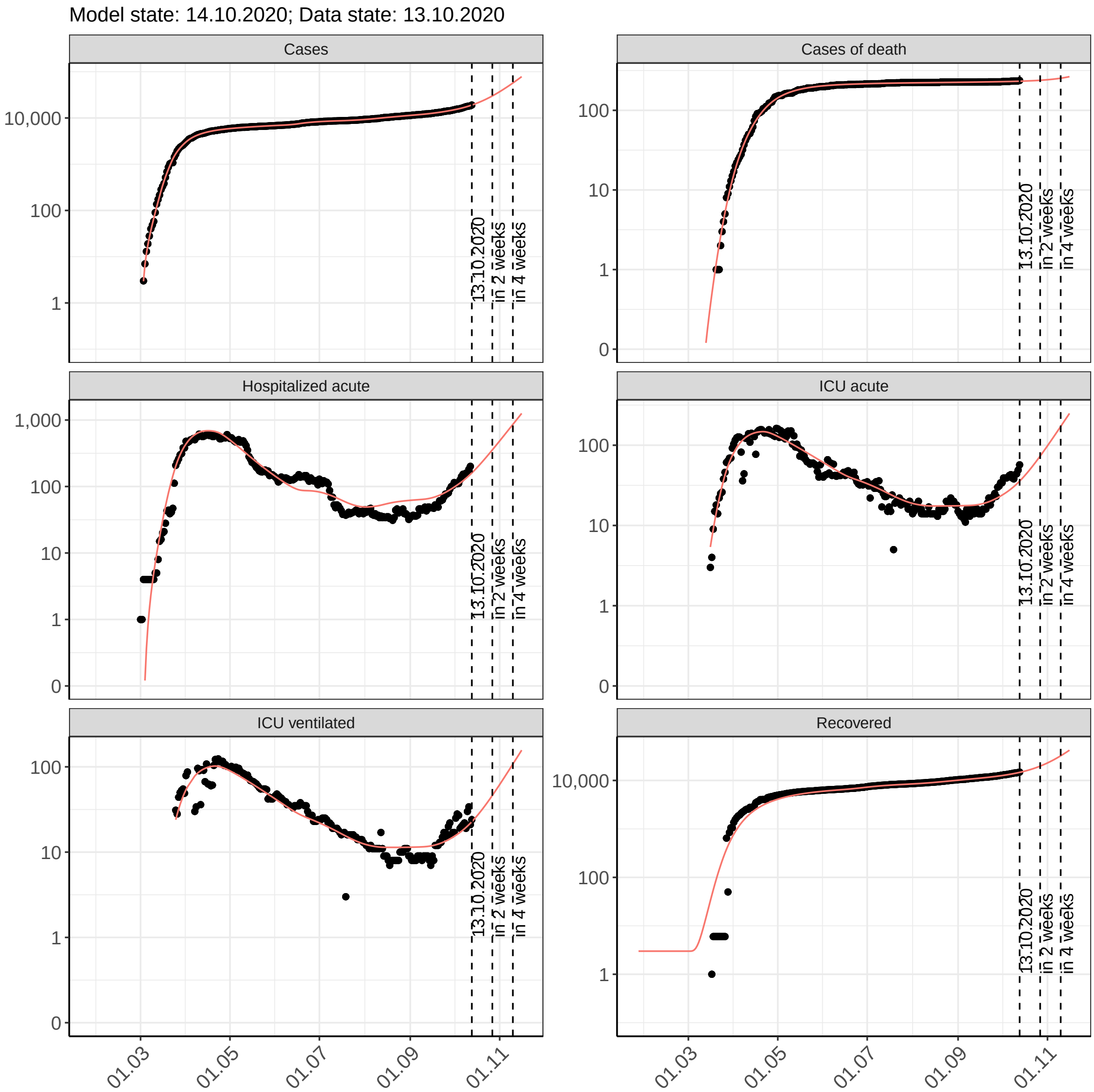



Figure 39: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Berlin for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.40 and 41 represent the model prediction for the next 8 weeks for Berlin on a linear (40) and a semi-logarithmic (41) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

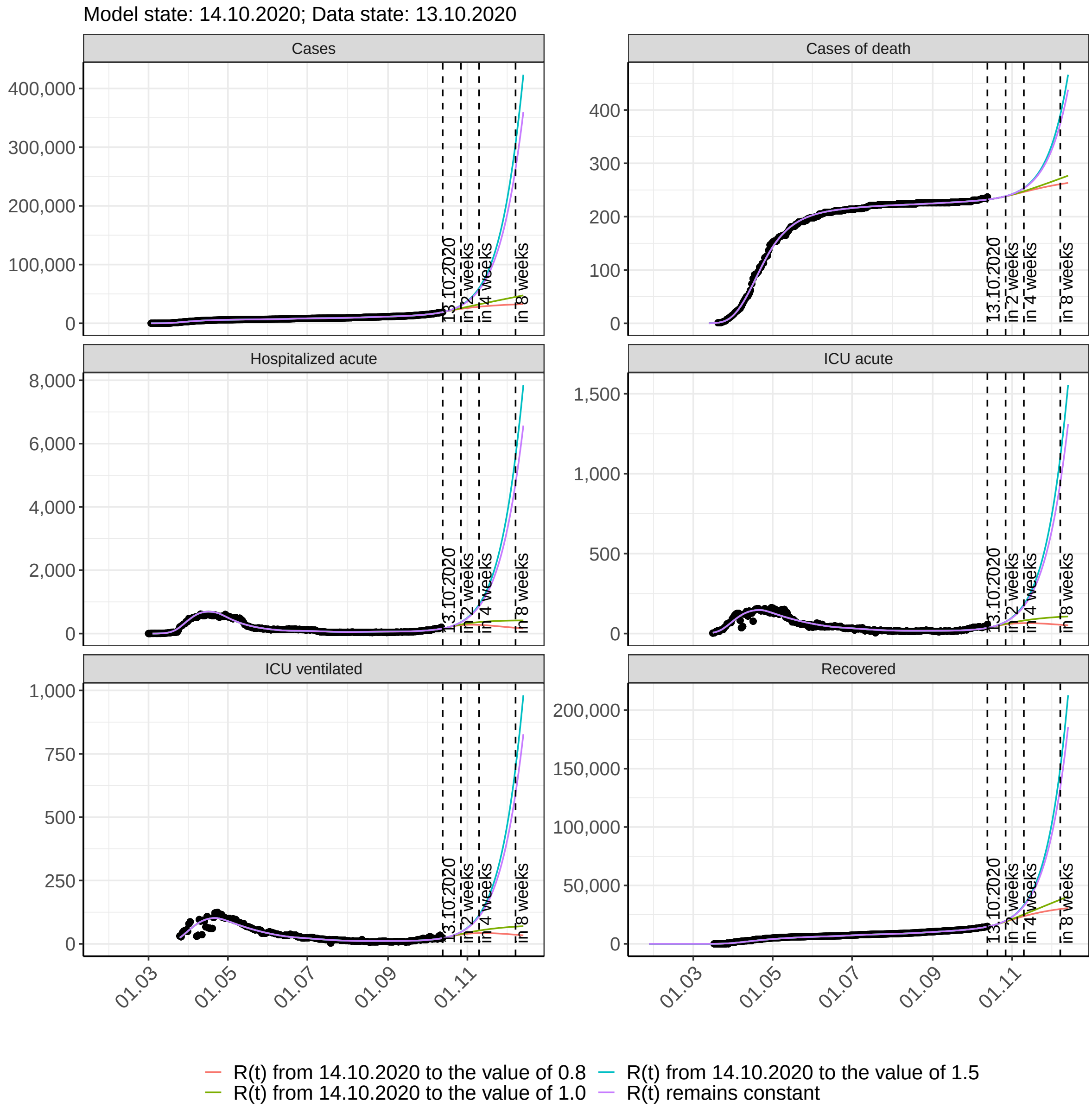



Figure 40: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Berlin assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

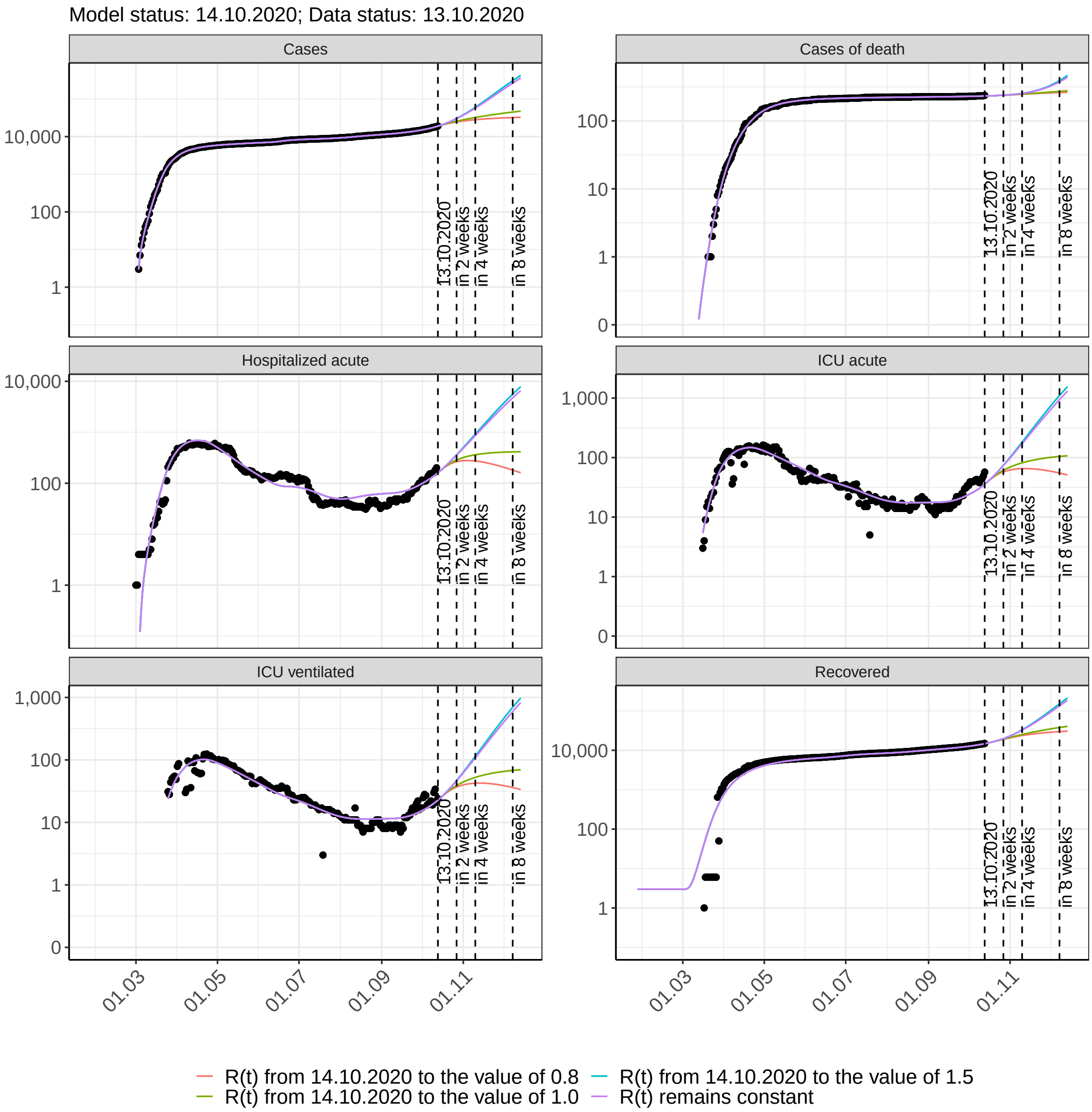



Figure 41: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Berlin assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

**Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020**

Fig. 42 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

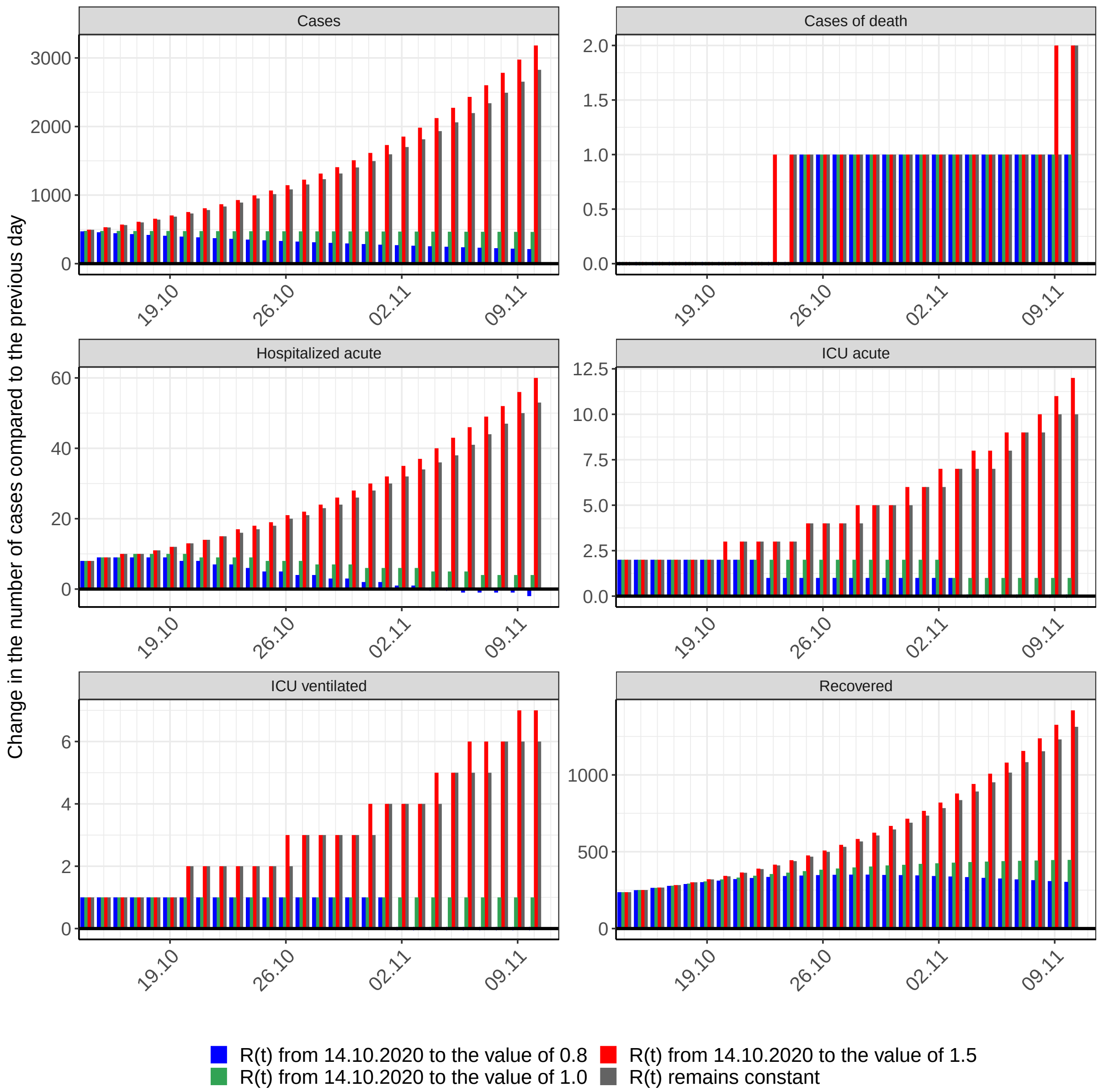



Figure 42: Simulation of daily new cases for the next 4 weeks - Berlin

# 5 Brandenburg

## 5.1 Model description

Fig. 43 depicts the results of the modeling (lines) compared to the observed data (points) for Brandenburg on a linear (A) and semi-logarithmic (B) scale.

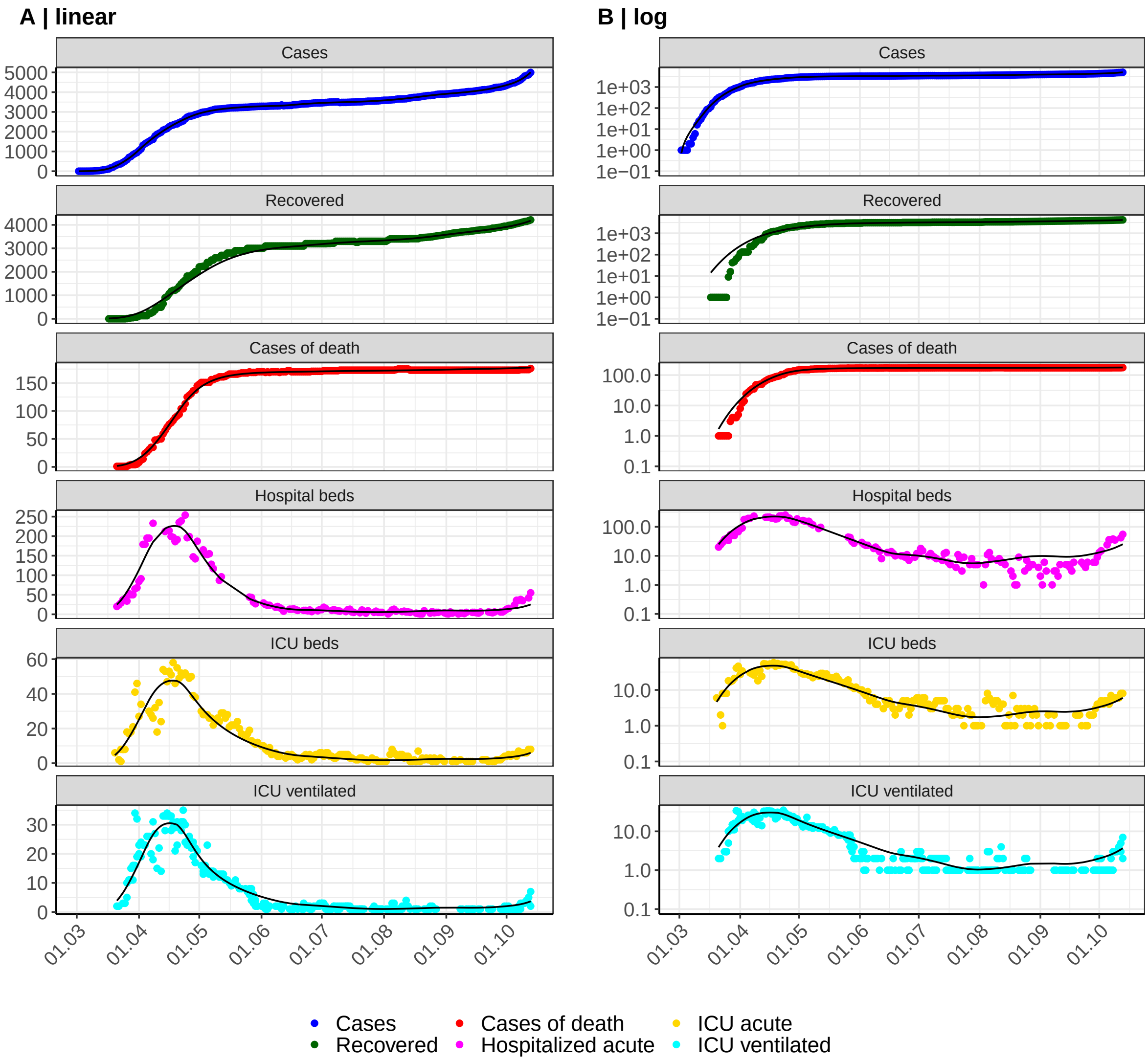



Figure 43: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Brandenburg. Points: reported data; lines: model description.

Fig. 44 shows the goodness-of-fit for Brandenburg. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

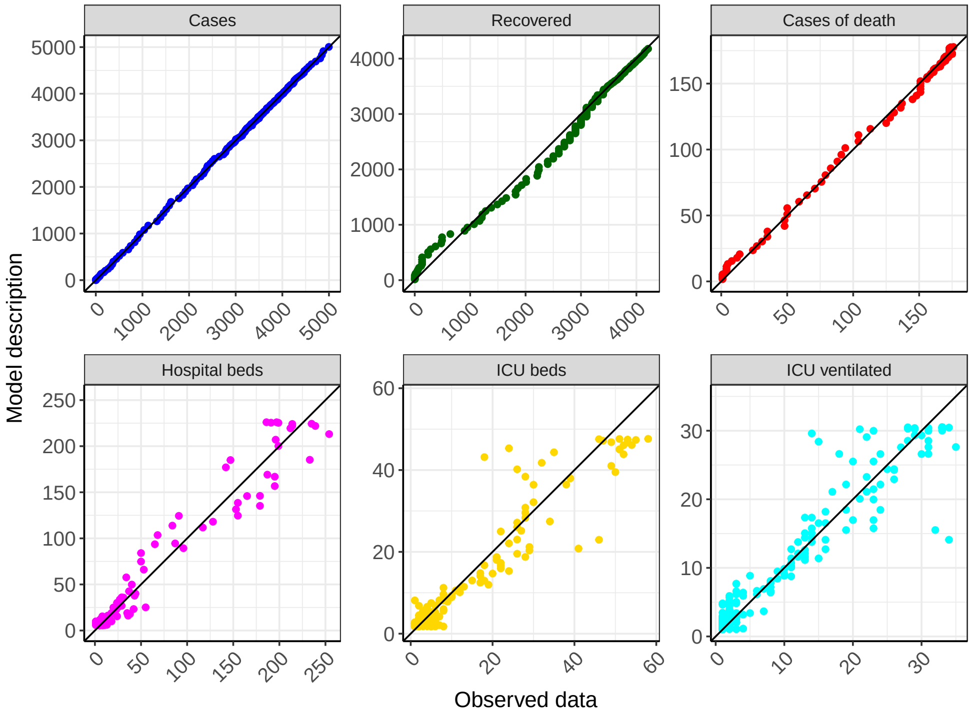



Figure 44: Goodness-of-fit plots for Brandenburg. Lines: lines of identity.

Fig. 45 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Brandenburg (red line) in comparison with the other federal states (grey lines).

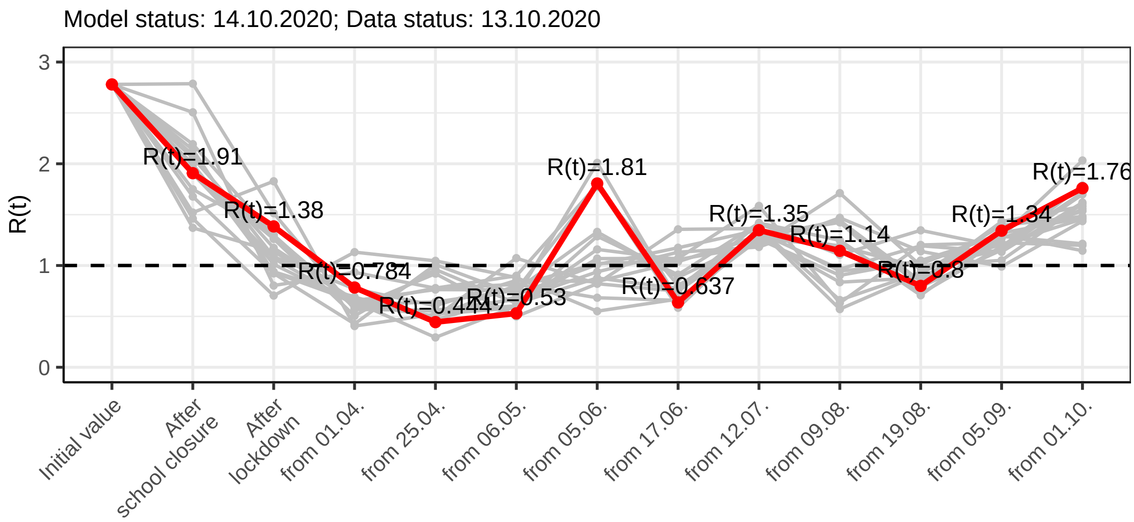



Figure 45: R(t) values before and after the NPIs for Brandenburg

Fig. 46 shows the R(t) estimated value for Brandenburg (red line) over time in comparison with the other federal states (grey lines).

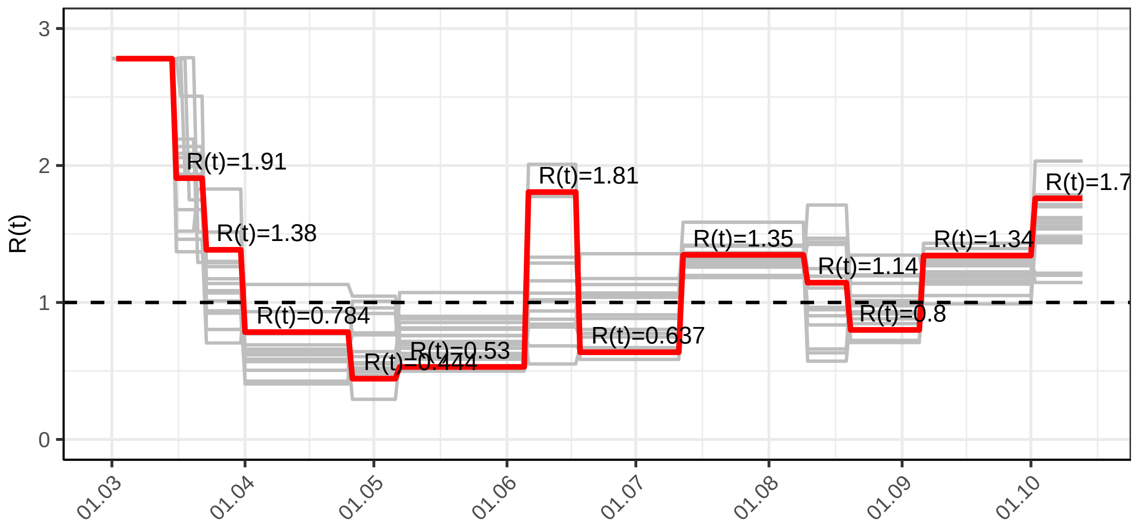



Figure 46: R(t) values over time for Brandenburg

Fig. 47 shows the changes in hospitalization and death rates for Brandenburg (red line) over time compared to the other states (grey lines).

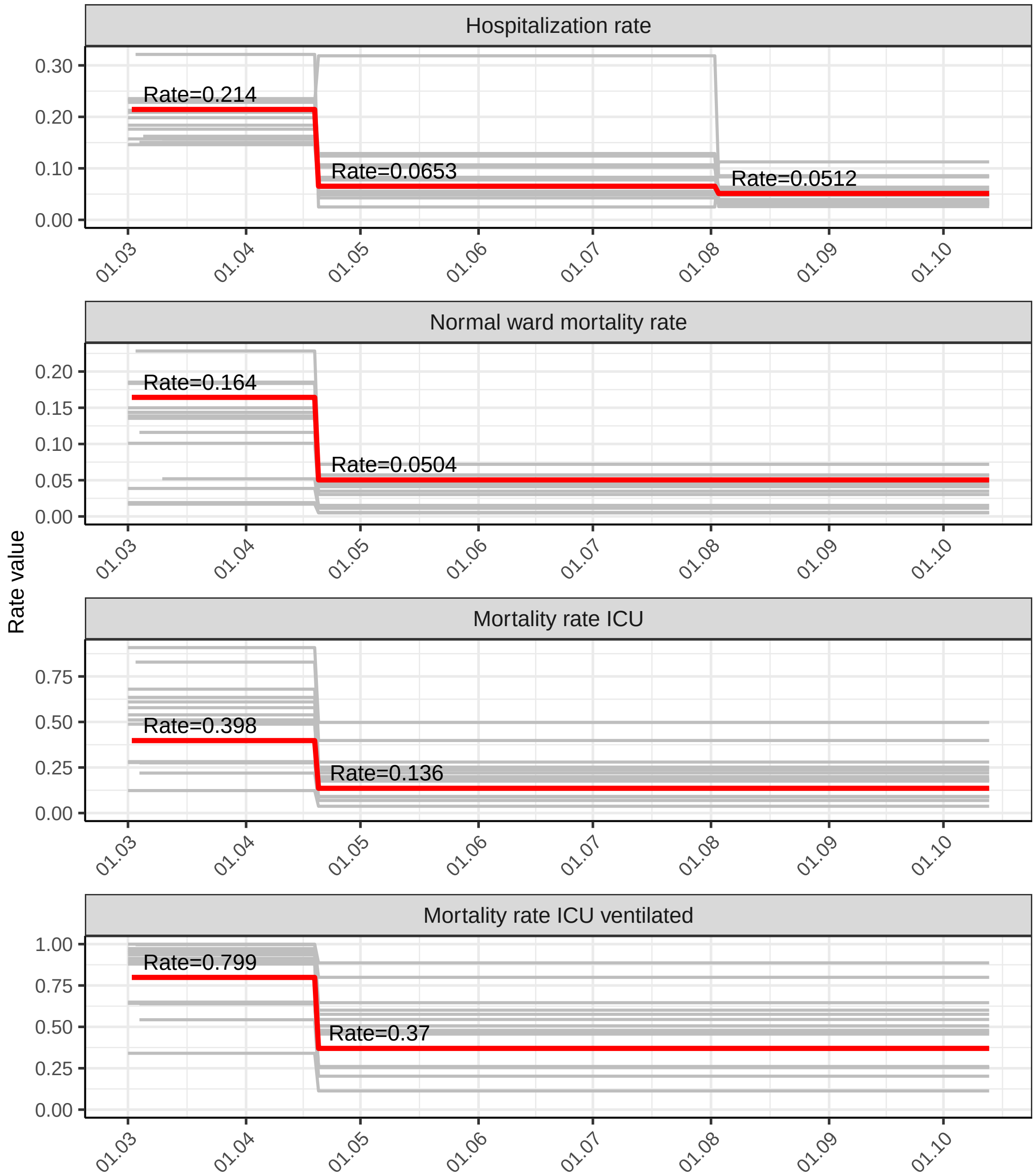



Figure 47: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Brandenburg

## 5.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.76)

Fig.48 and 49 depict the the model predictions for the next 4 weeks for Brandenburg on a linear (48) and a semi-logarithmic (49) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

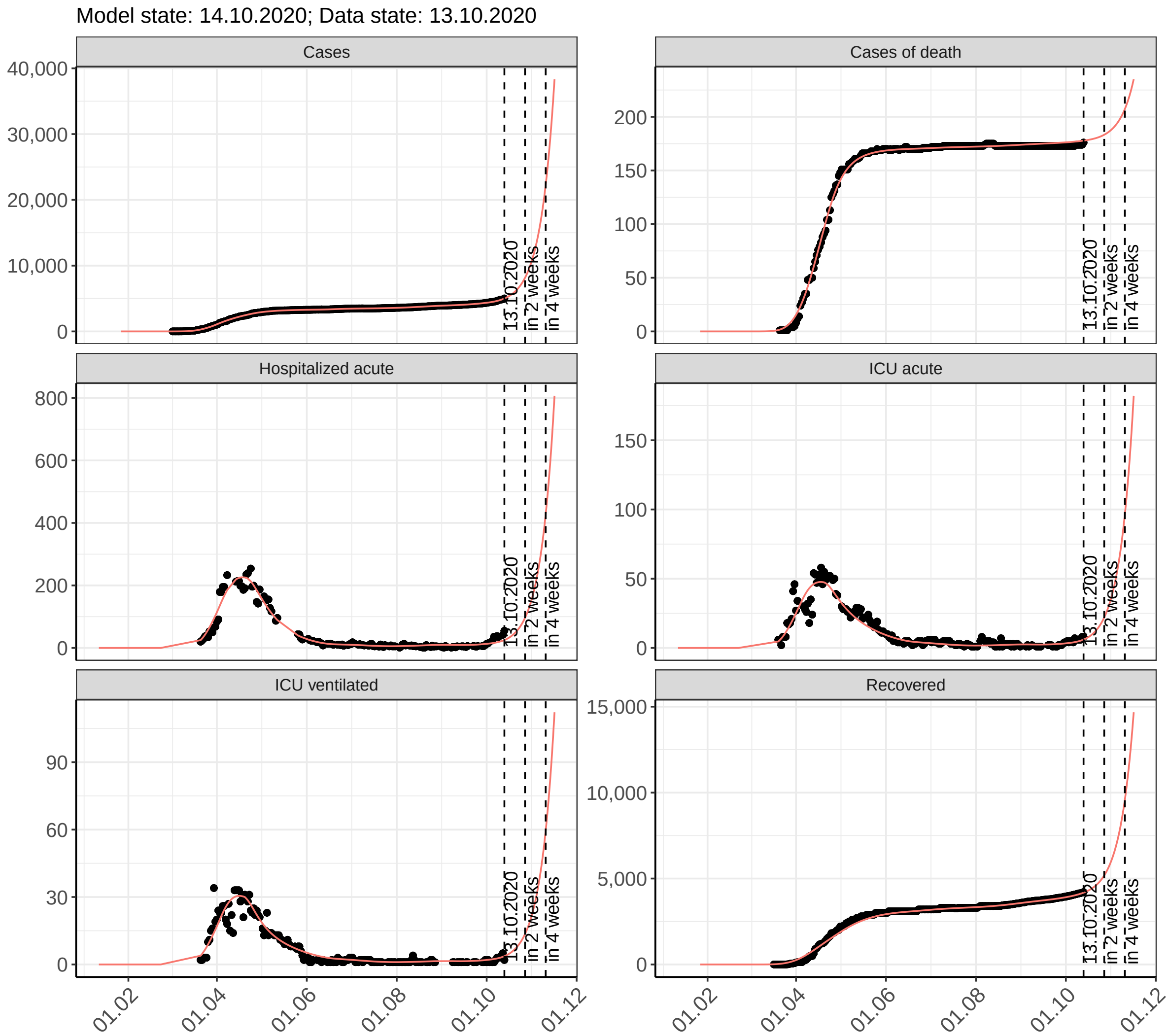



Figure 48: Representation of the model predictions for Brandenburg for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

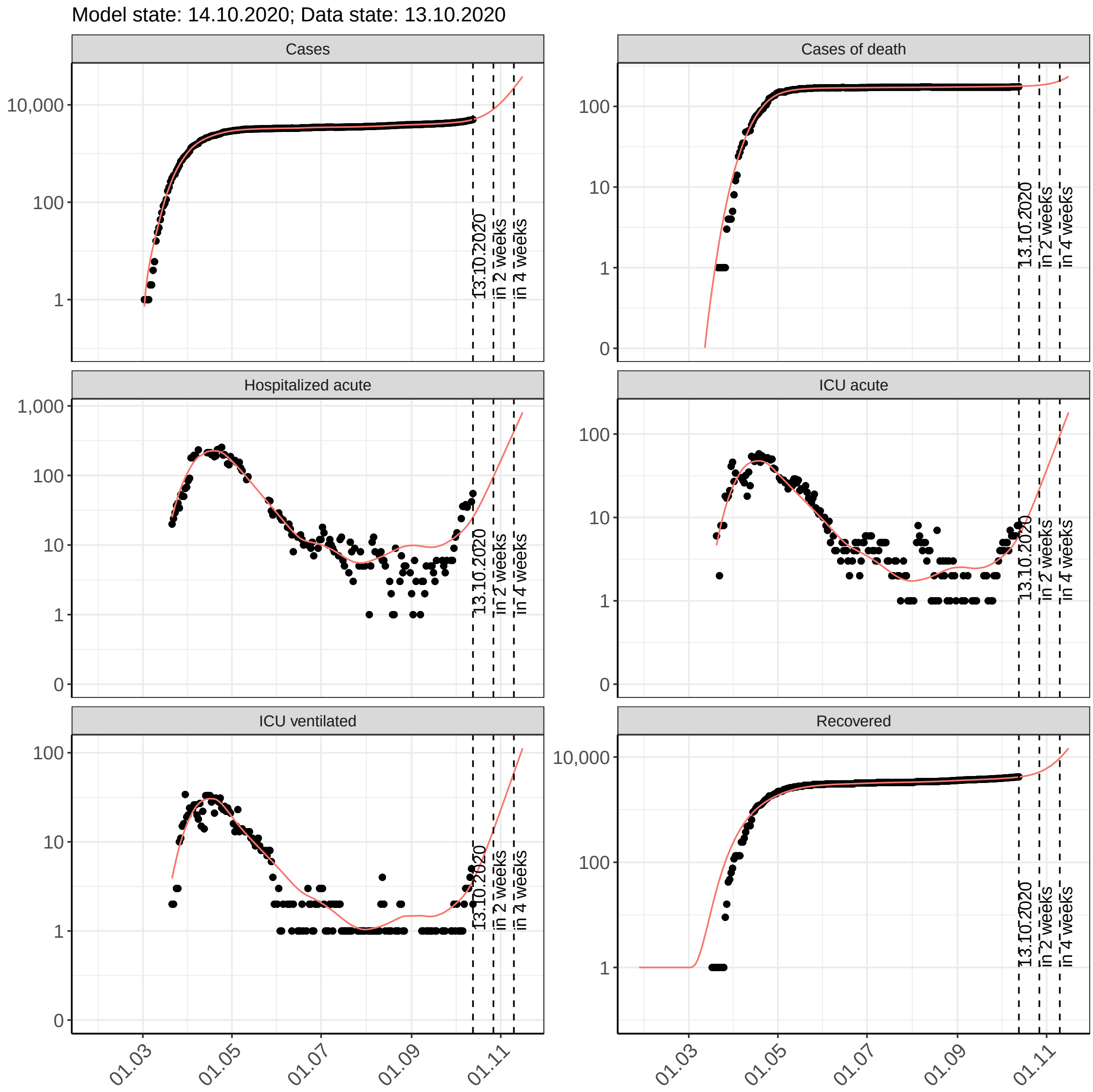



Figure 49: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Brandenburg for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.50 and 51 represent the model prediction for the next 8 weeks for Brandenburg on a linear (50) and a semi-logarithmic (51) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

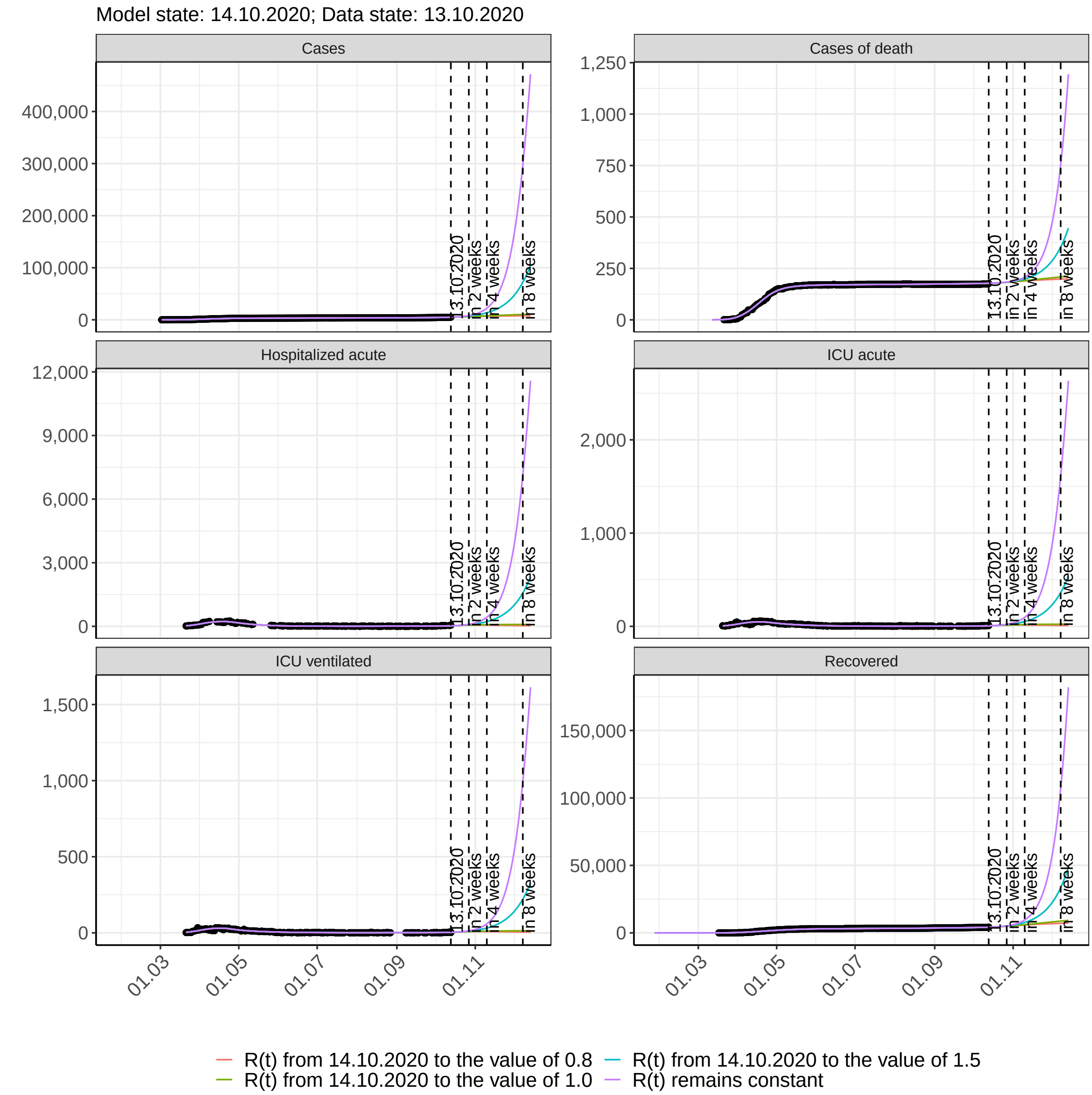



Figure 50: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Brandenburg assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

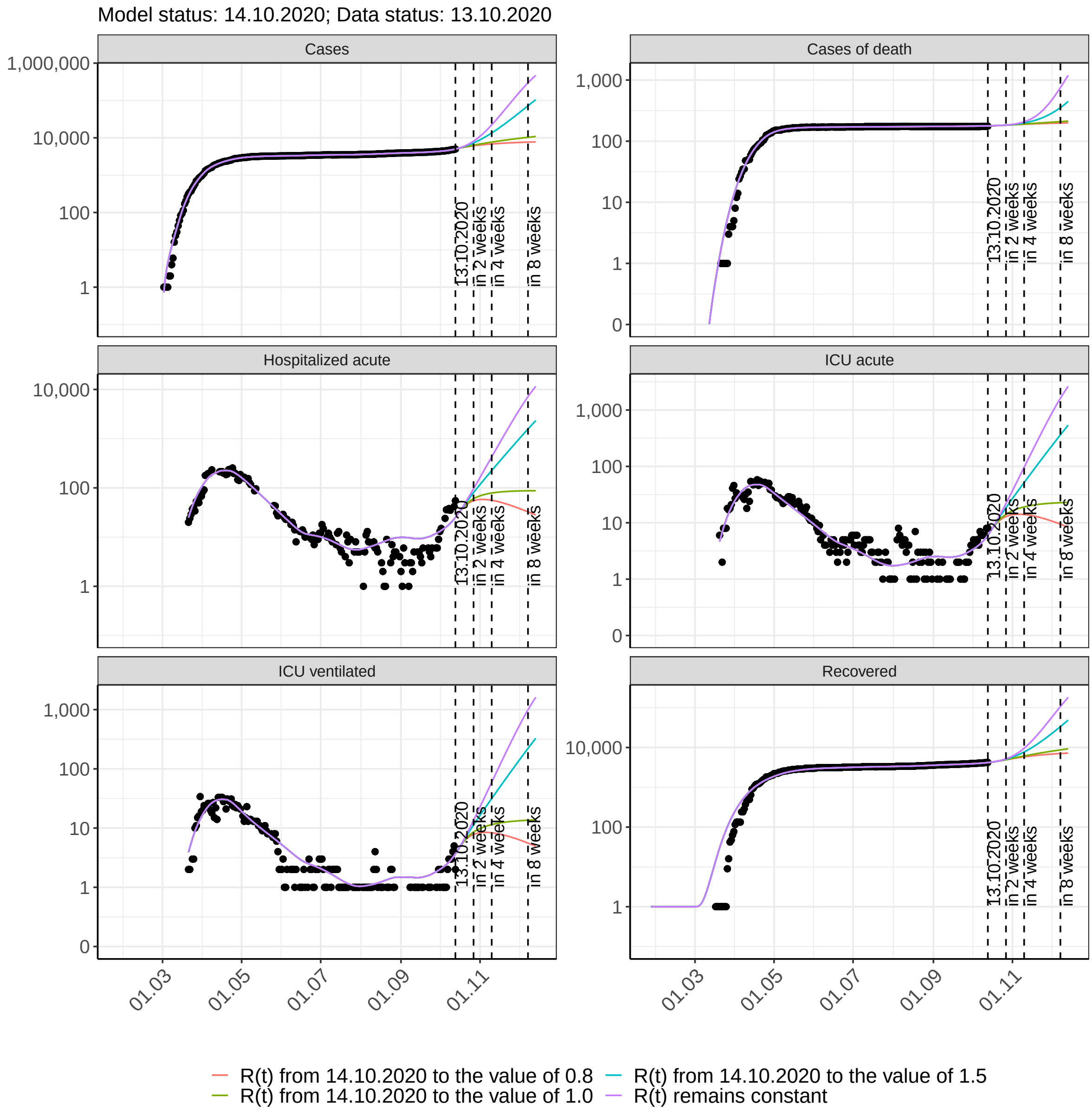



Figure 51: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Brandenburg assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 52 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

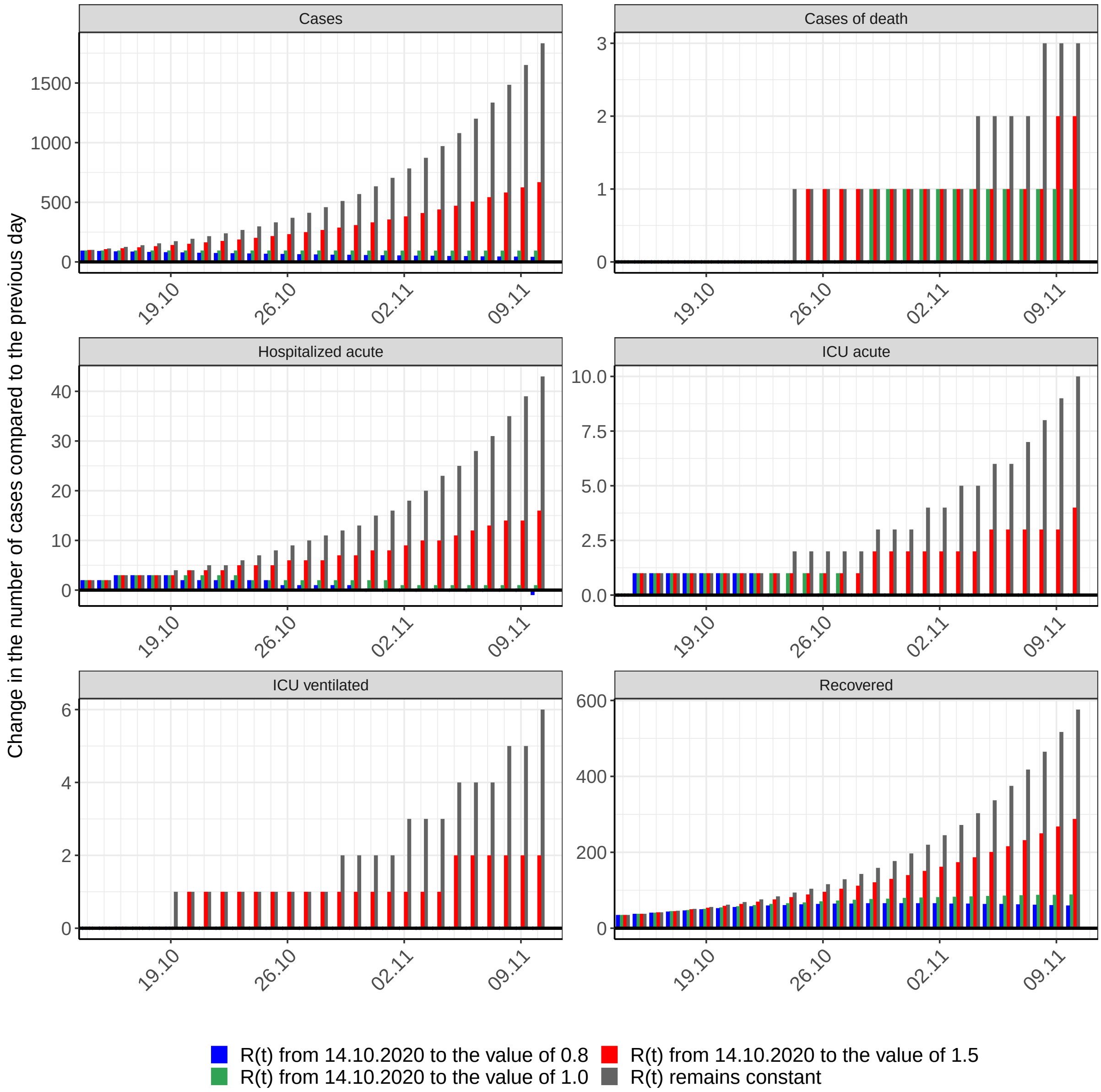



Figure 52: Simulation of daily new cases for the next 4 weeks - Brandenburg

# 6 Bremen

## 6.1 Model description

Fig. 53 depicts the results of the modeling (lines) compared to the observed data (points) for Bremen on a linear (A) and semi-logarithmic (B) scale.

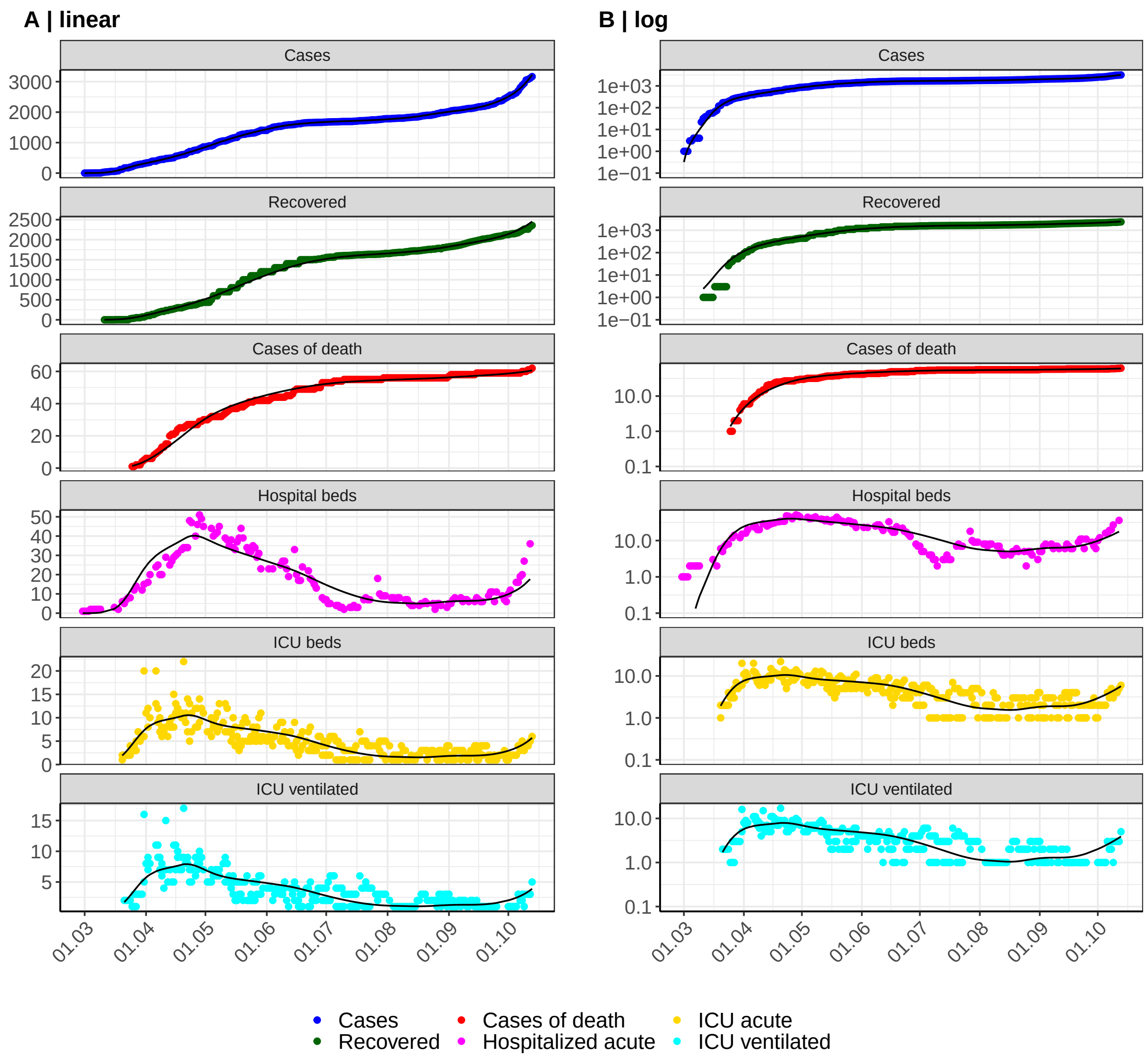



Figure 53: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Bremen. Points: reported data; lines: model description.

Fig. 54 shows the goodness-of-fit for Bremen. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

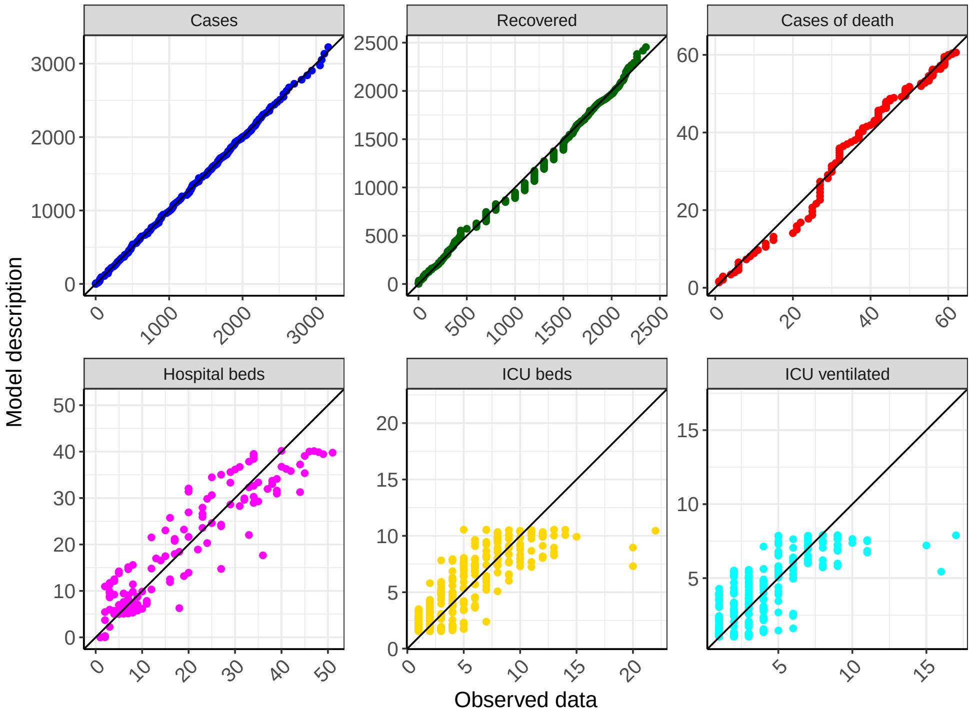



Figure 54: Goodness-of-fit plots for Bremen. Lines: lines of identity.

Fig. 55 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Bremen (red line) in comparison with the other federal states (grey lines).

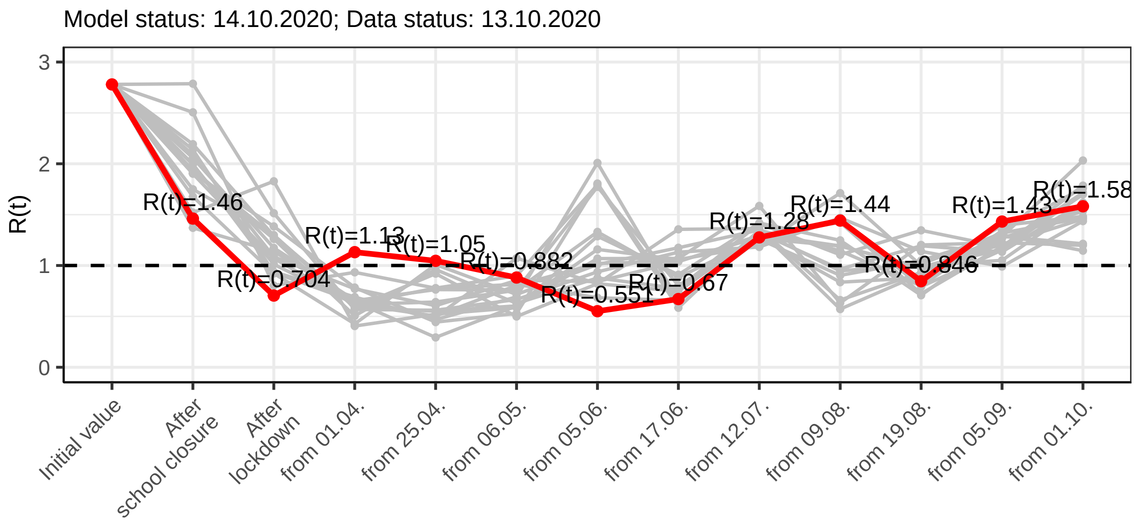



Figure 55: R(t) values before and after the NPIs for Bremen

Fig. 56 shows the R(t) estimated value for Bremen (red line) over time in comparison with the other federal states (grey lines).

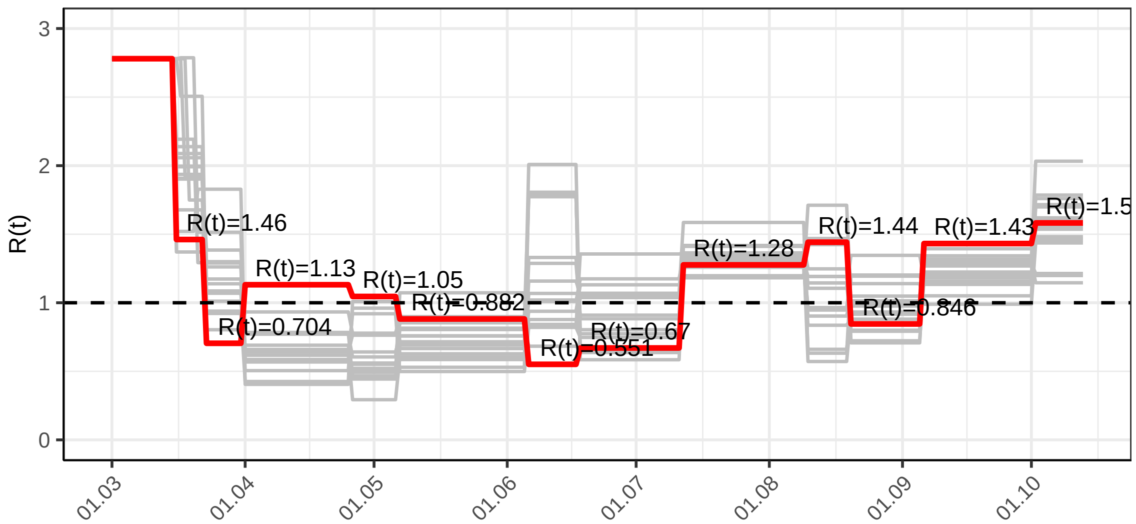



Figure 56: R(t) values over time for Bremen

Fig. 57 shows the changes in hospitalization and death rates for Bremen (red line) over time compared to the other states (grey lines).

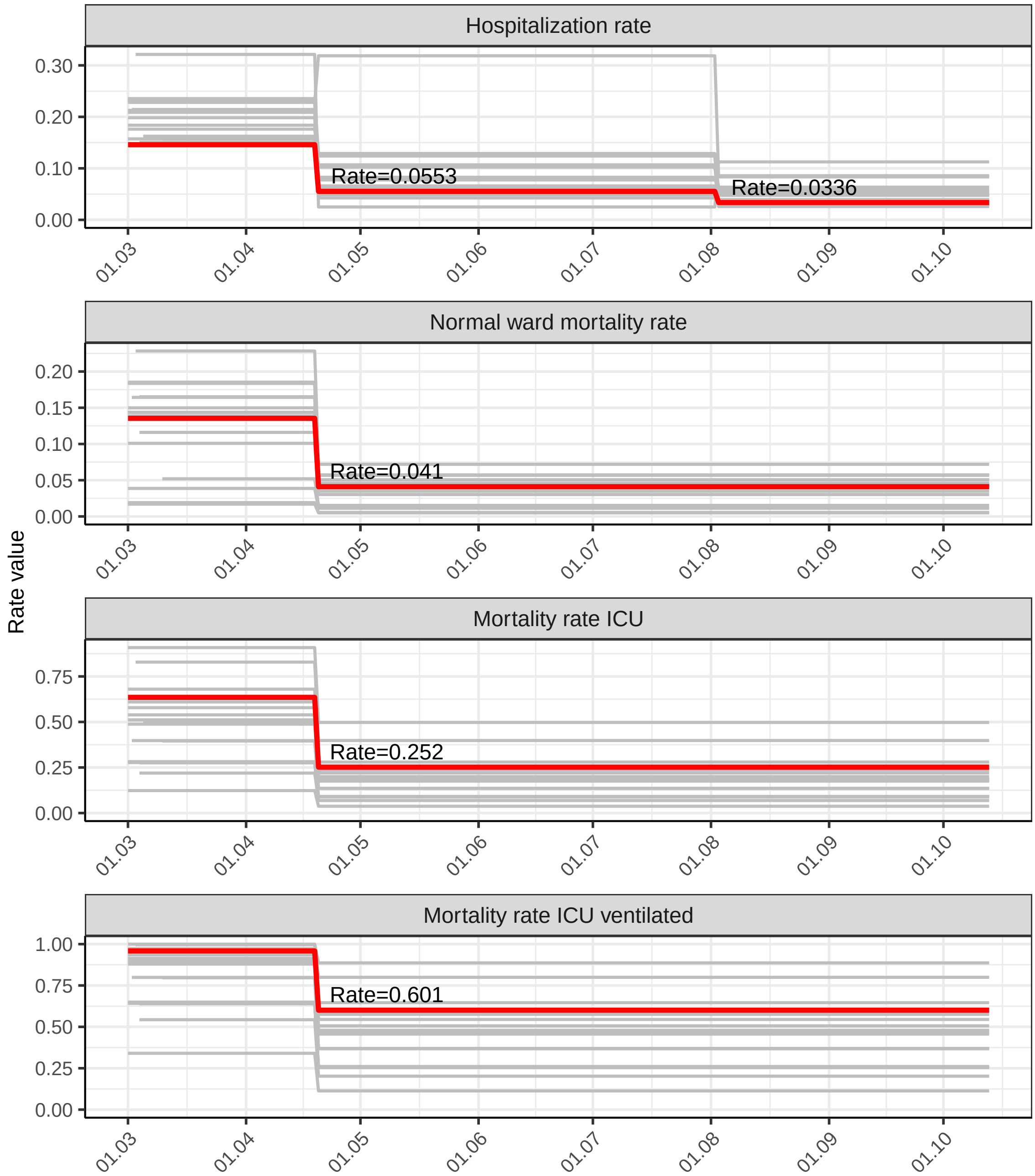



Figure 57: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Bremen

## 6.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.58)

Fig.58 and 59 depict the the model predictions for the next 4 weeks for Bremen on a linear (58) and a semi-logarithmic (59) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

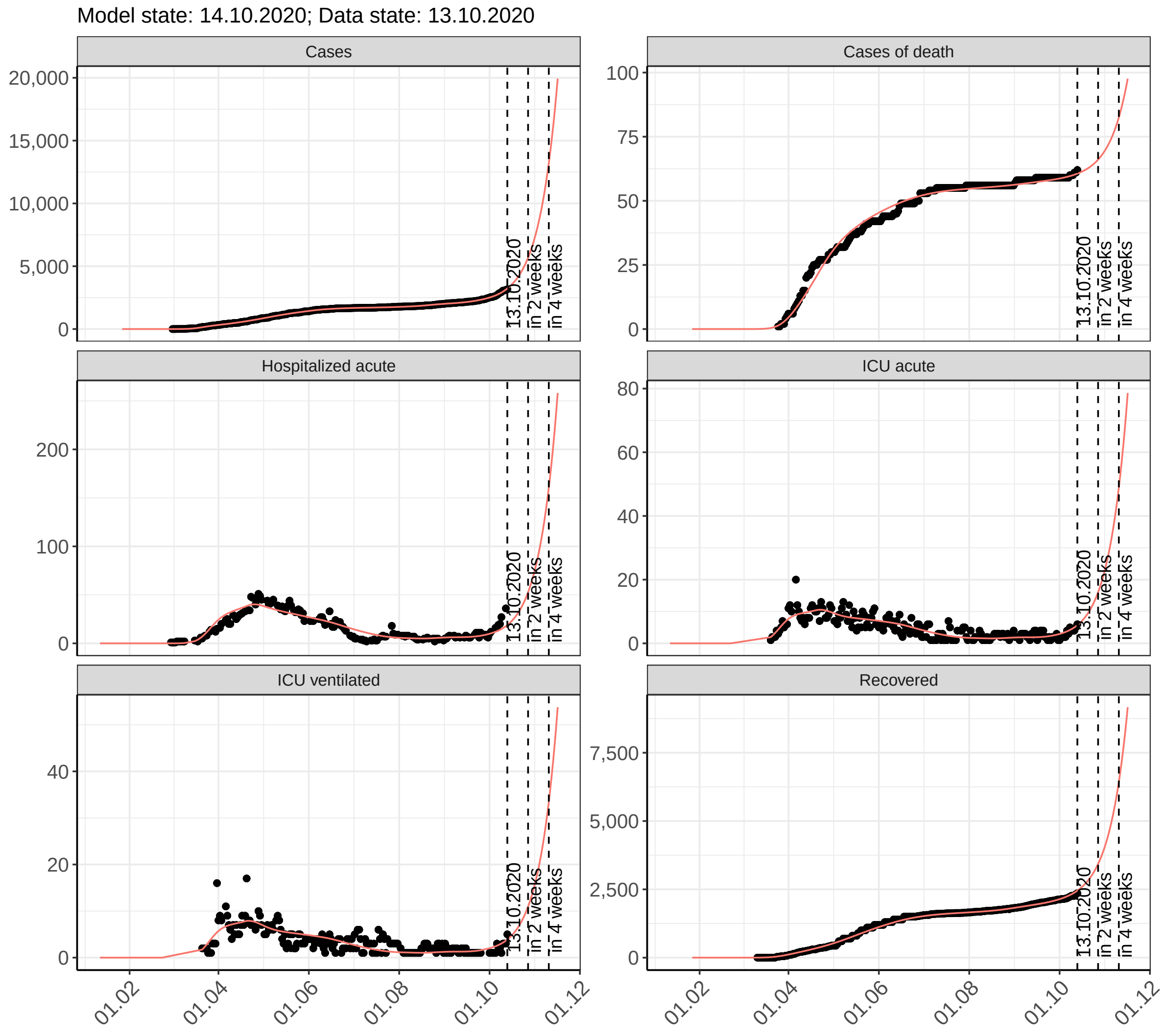



Figure 58: Representation of the model predictions for Bremen for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

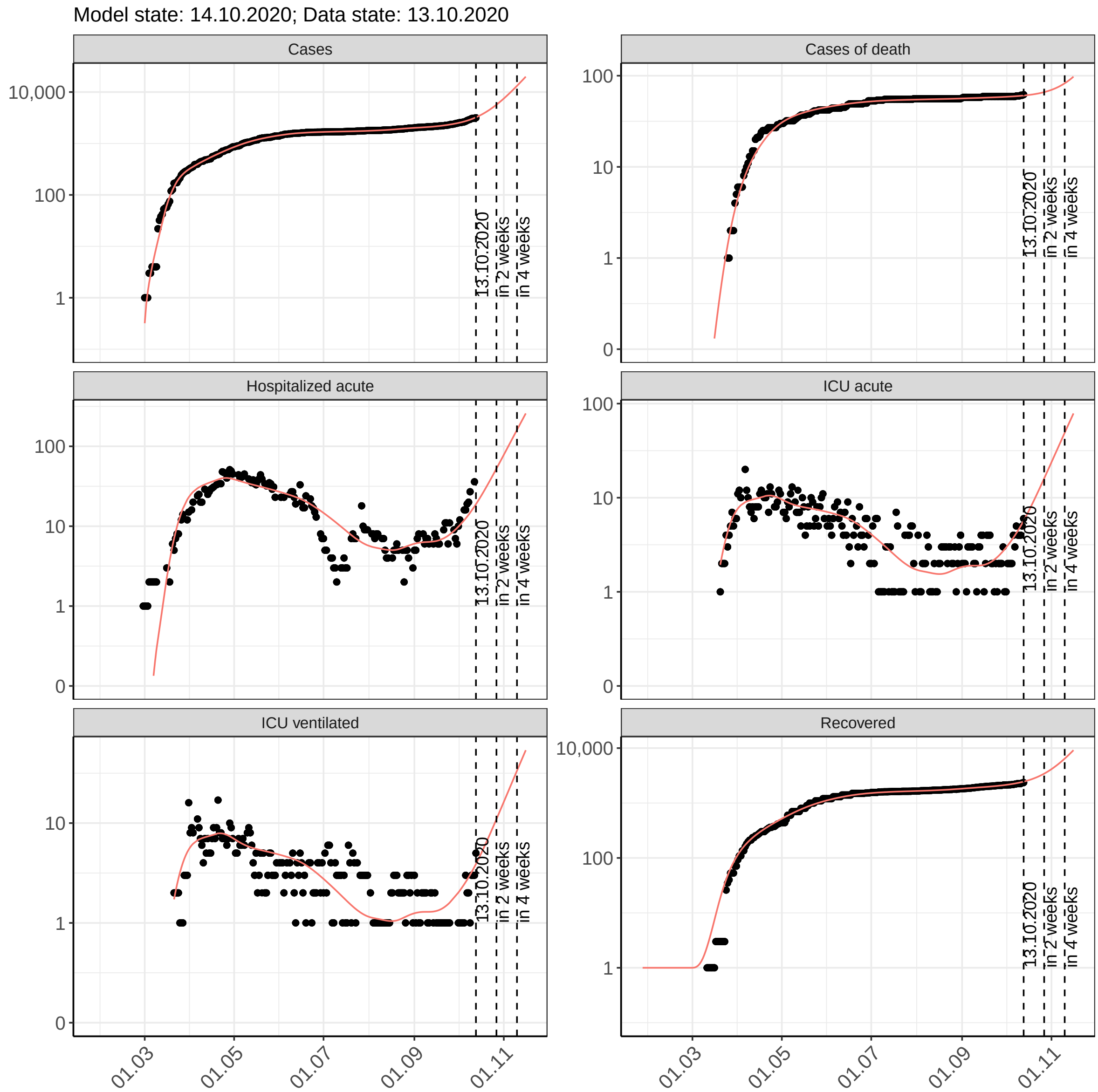



Figure 59: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Bremen for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.60 and 61 represent the model prediction for the next 8 weeks for Bremen on a linear (60) and a semi-logarithmic (61) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

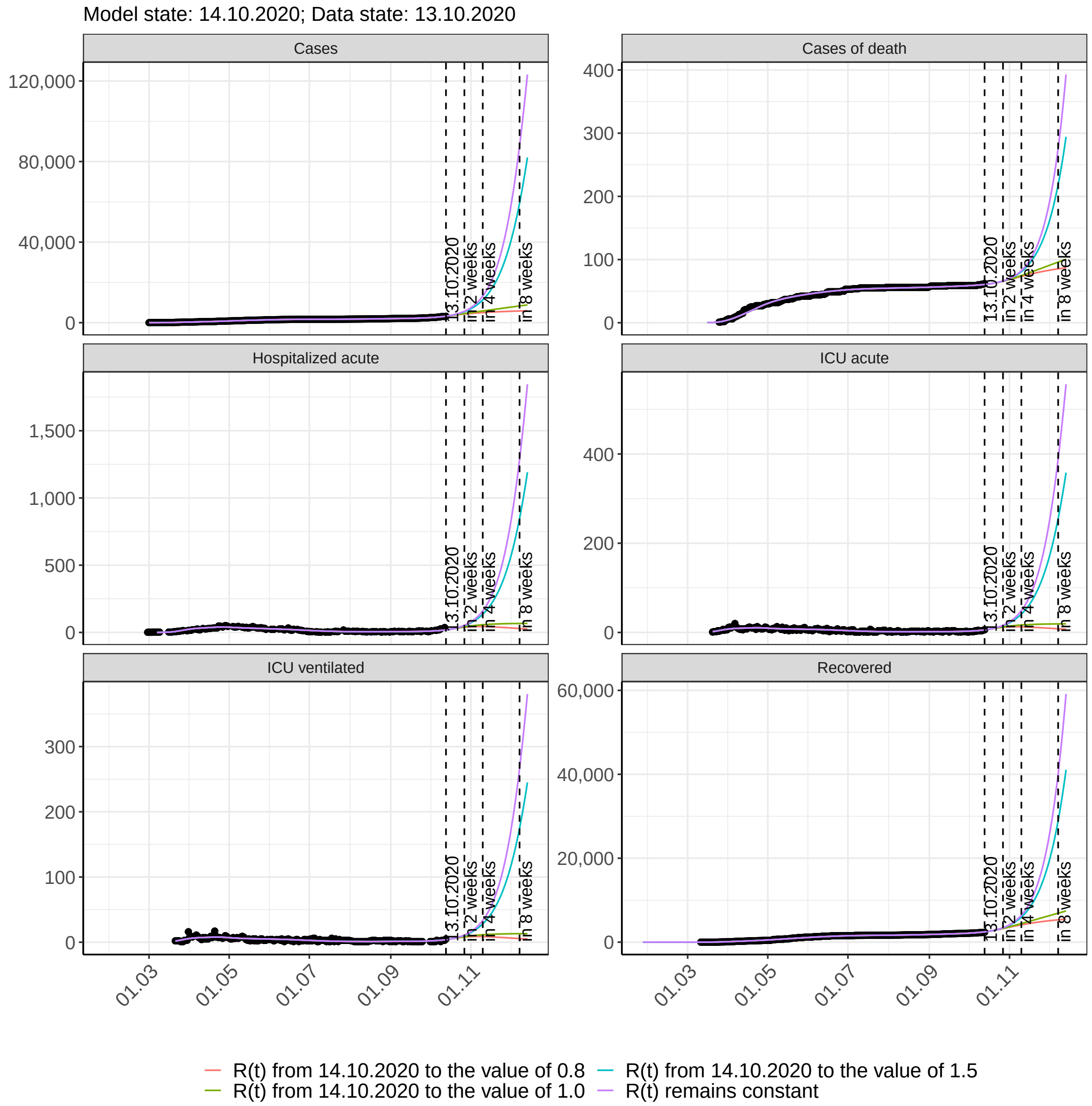



Figure 60: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Bremen assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

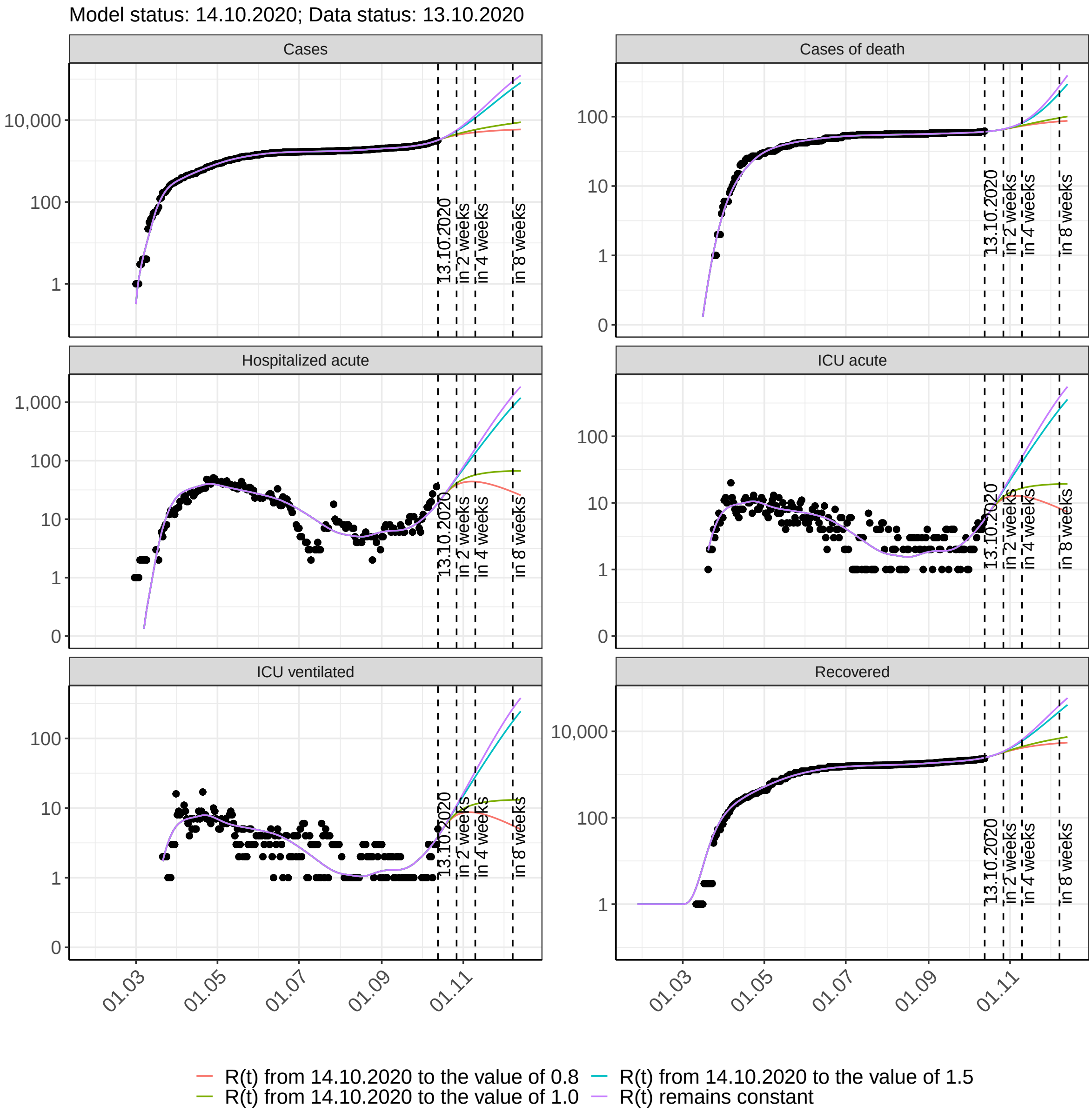



Figure 61: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Bremen assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

**Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020**

Fig. 62 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

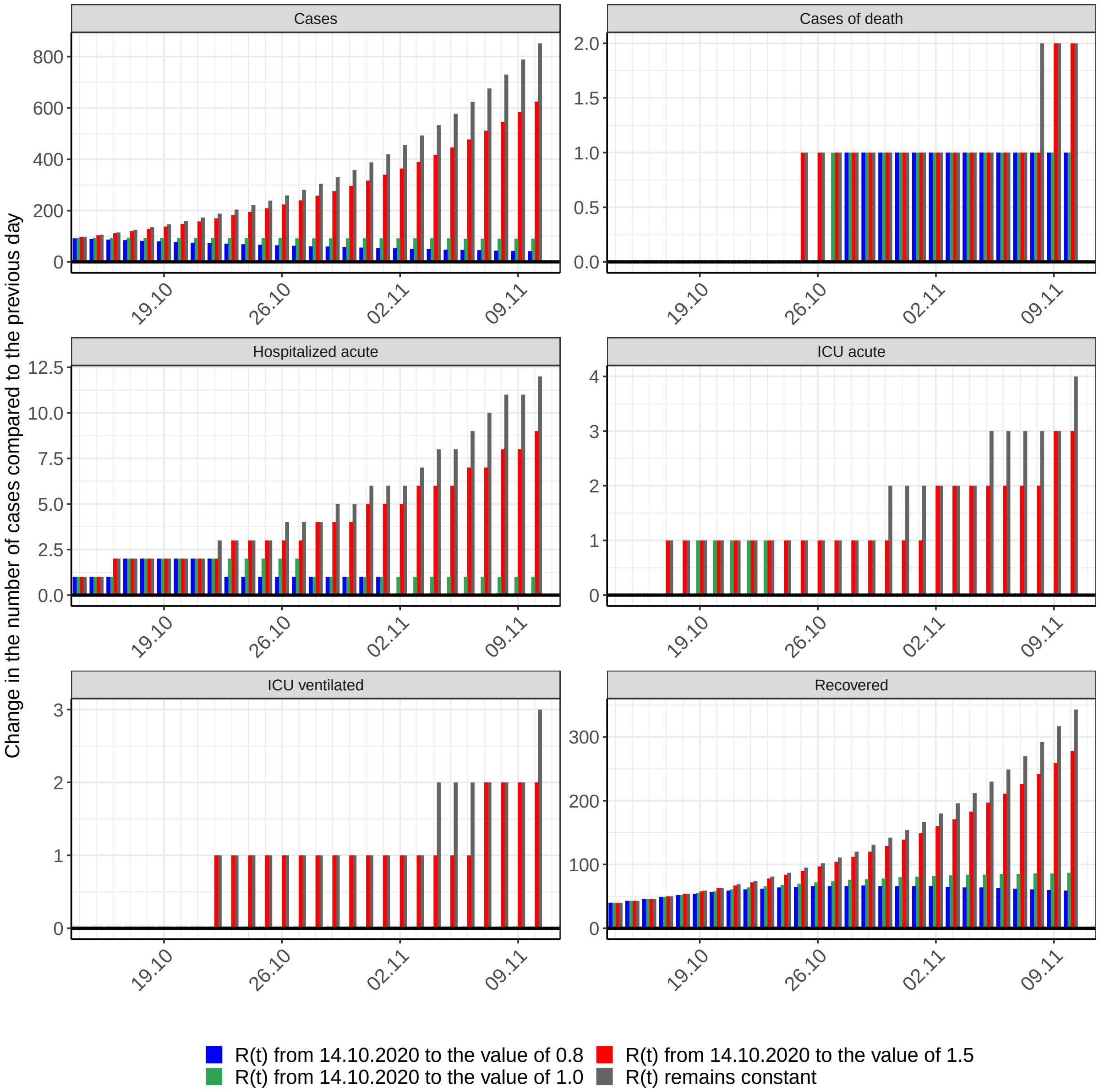



Figure 62: Simulation of daily new cases for the next 4 weeks - Bremen

# 7 Hamburg

## 7.1 Model description

Fig. 63 depicts the results of the modeling (lines) compared to the observed data (points) for Hamburg on a linear (A) and semi-logarithmic (B) scale.

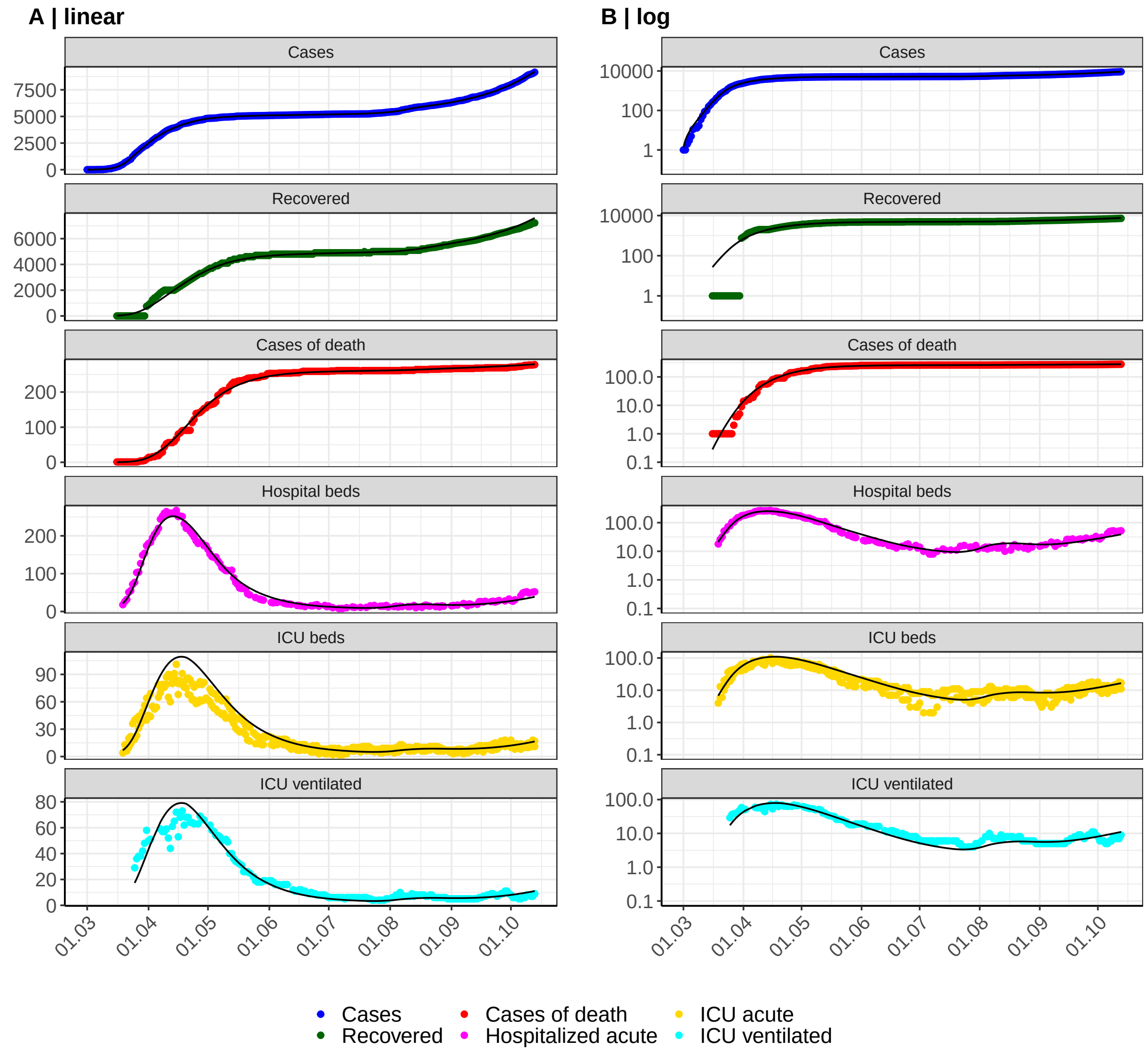



Figure 63: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Hamburg. Points: reported data; lines: model description.

Fig. 64 shows the goodness-of-fit for Hamburg. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

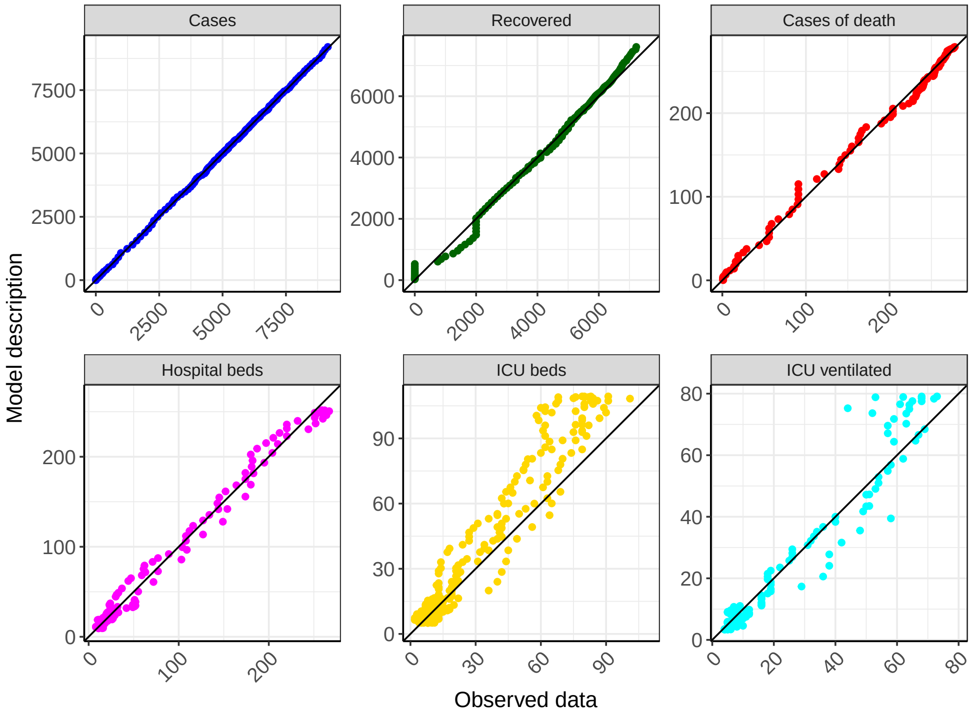



Figure 64: Goodness-of-fit plots for Hamburg. Lines: lines of identity.

Fig. 65 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Hamburg (red line) in comparison with the other federal states (grey lines).

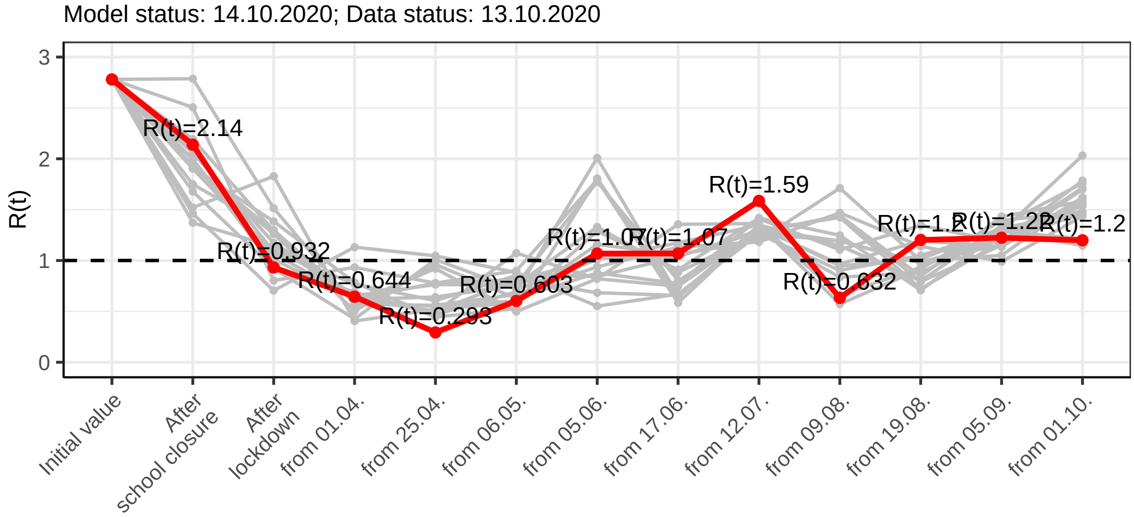



Figure 65: R(t) values before and after the NPIs for Hamburg

Fig. 66 shows the R(t) estimated value for Hamburg (red line) over time in comparison with the other federal states (grey lines).

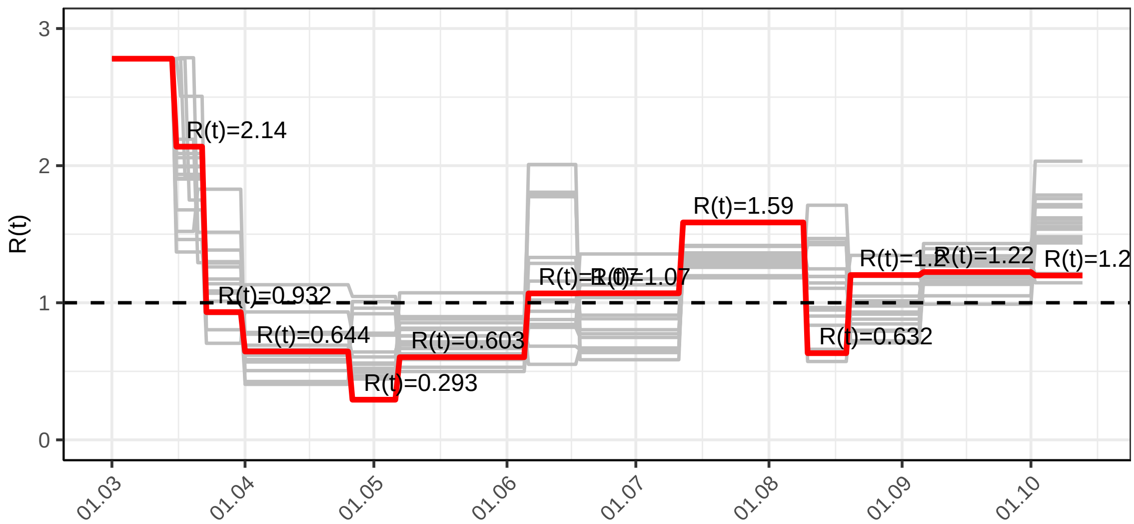



Figure 66: R(t) values over time for Hamburg

Fig. 67 shows the changes in hospitalization and death rates for Hamburg (red line) over time compared to the other states (grey lines).

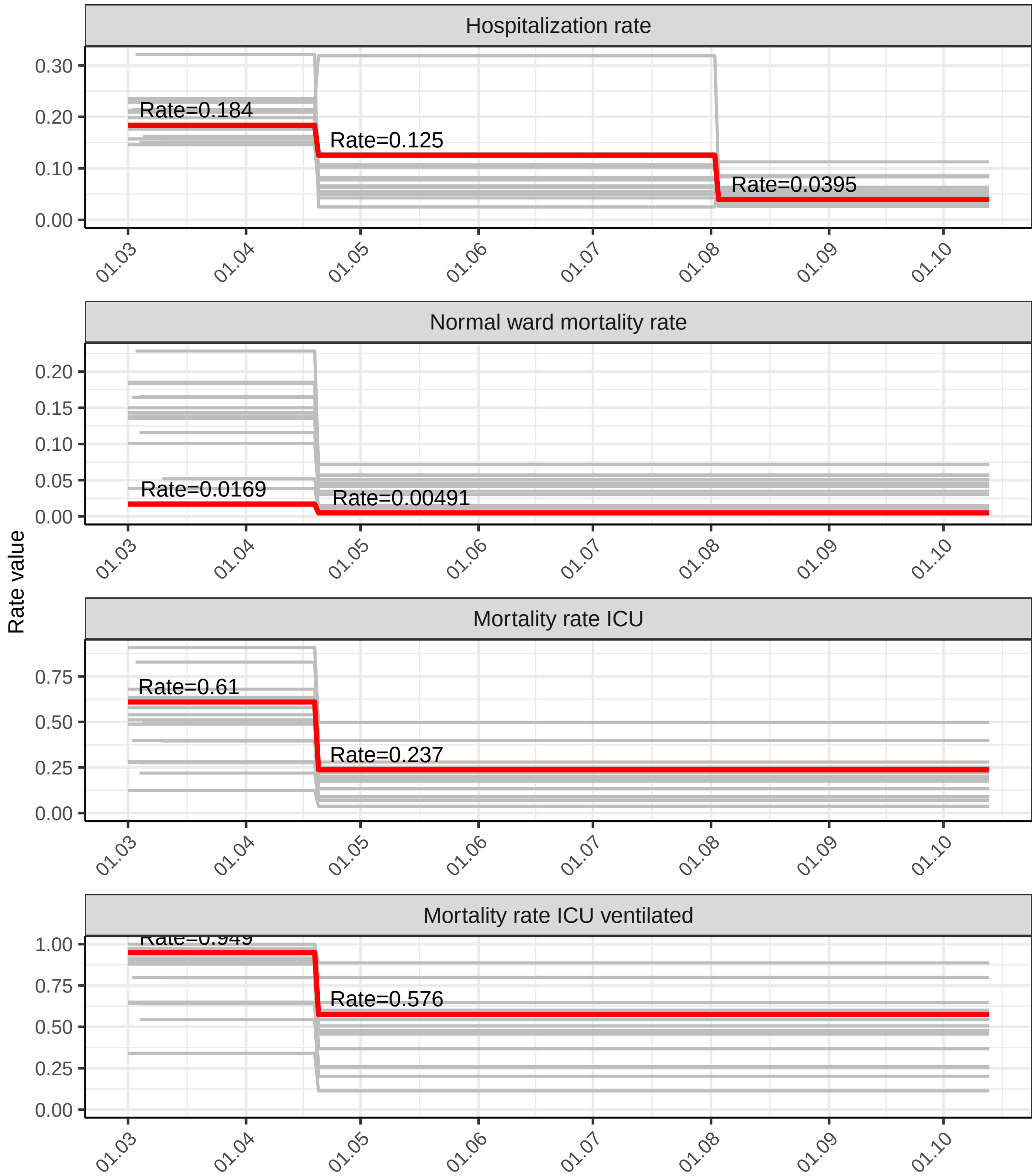



Figure 67: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Hamburg

## 7.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.2)

Fig.68 and 69 depict the the model predictions for the next 4 weeks for Hamburg on a linear (68) and a semi-logarithmic (69) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

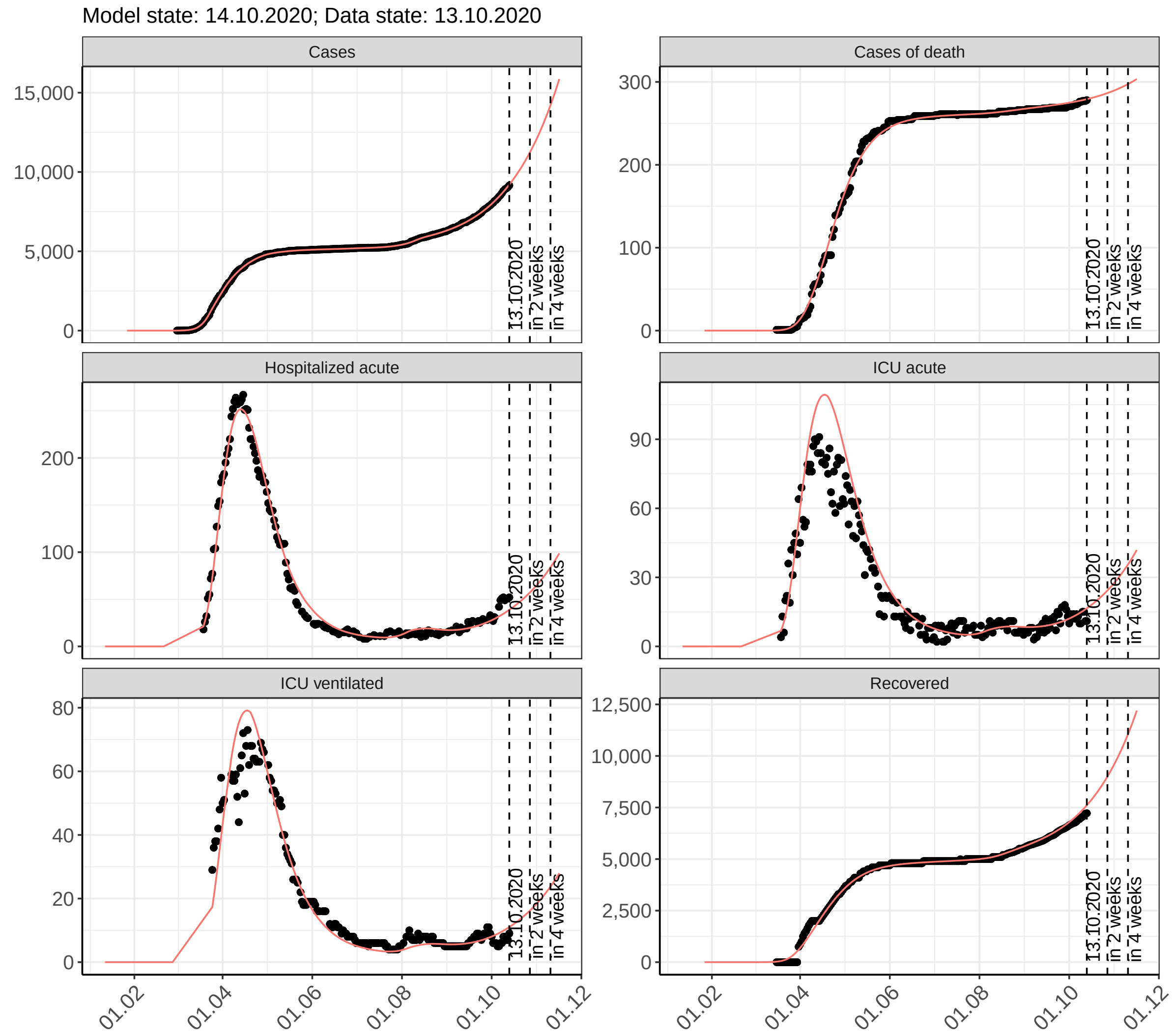



Figure 68: Representation of the model predictions for Hamburg for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

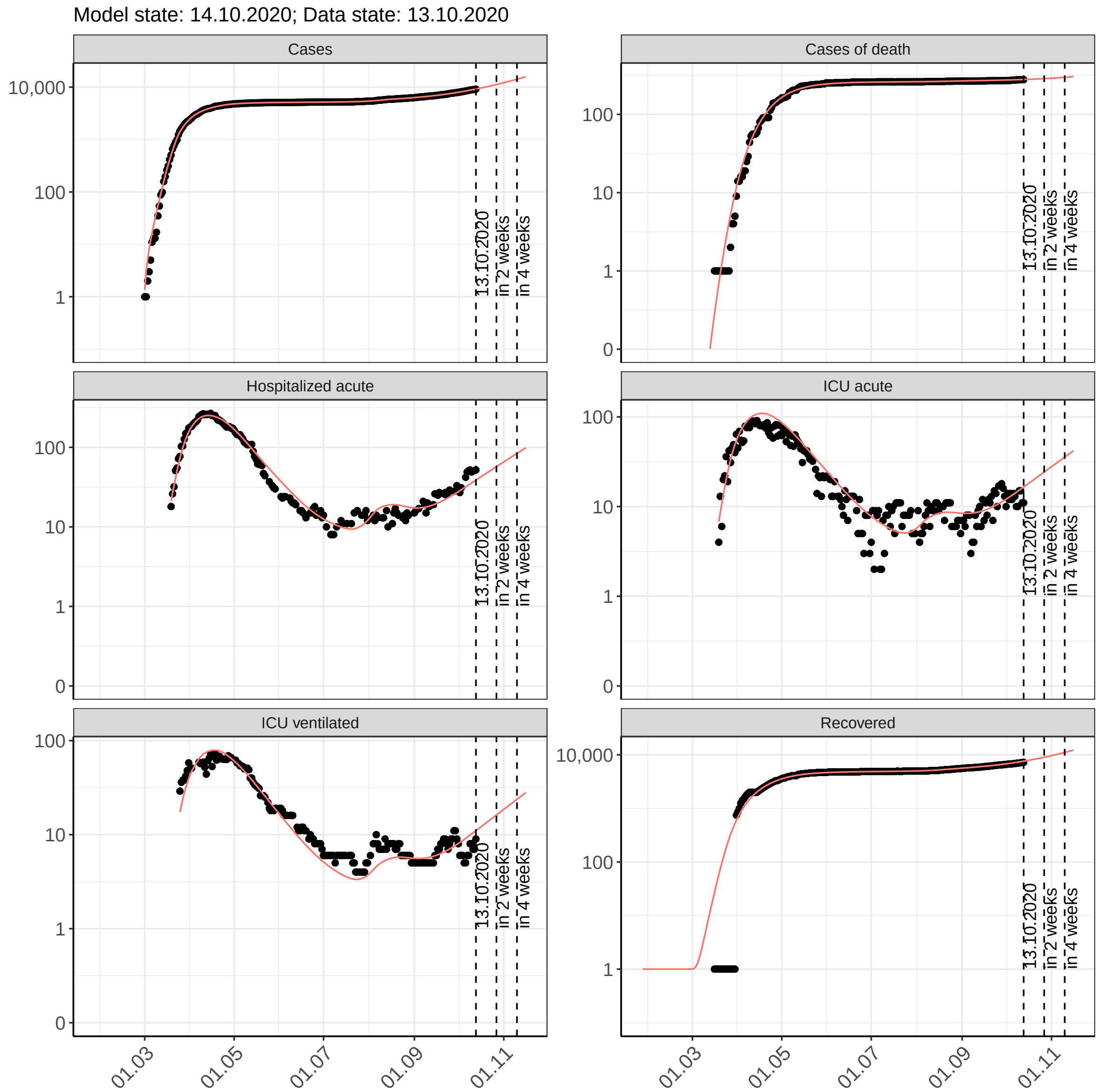



Figure 69: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Hamburg for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.70 and 71 represent the model prediction for the next 8 weeks for Hamburg on a linear (70) and a semi-logarithmic (71) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

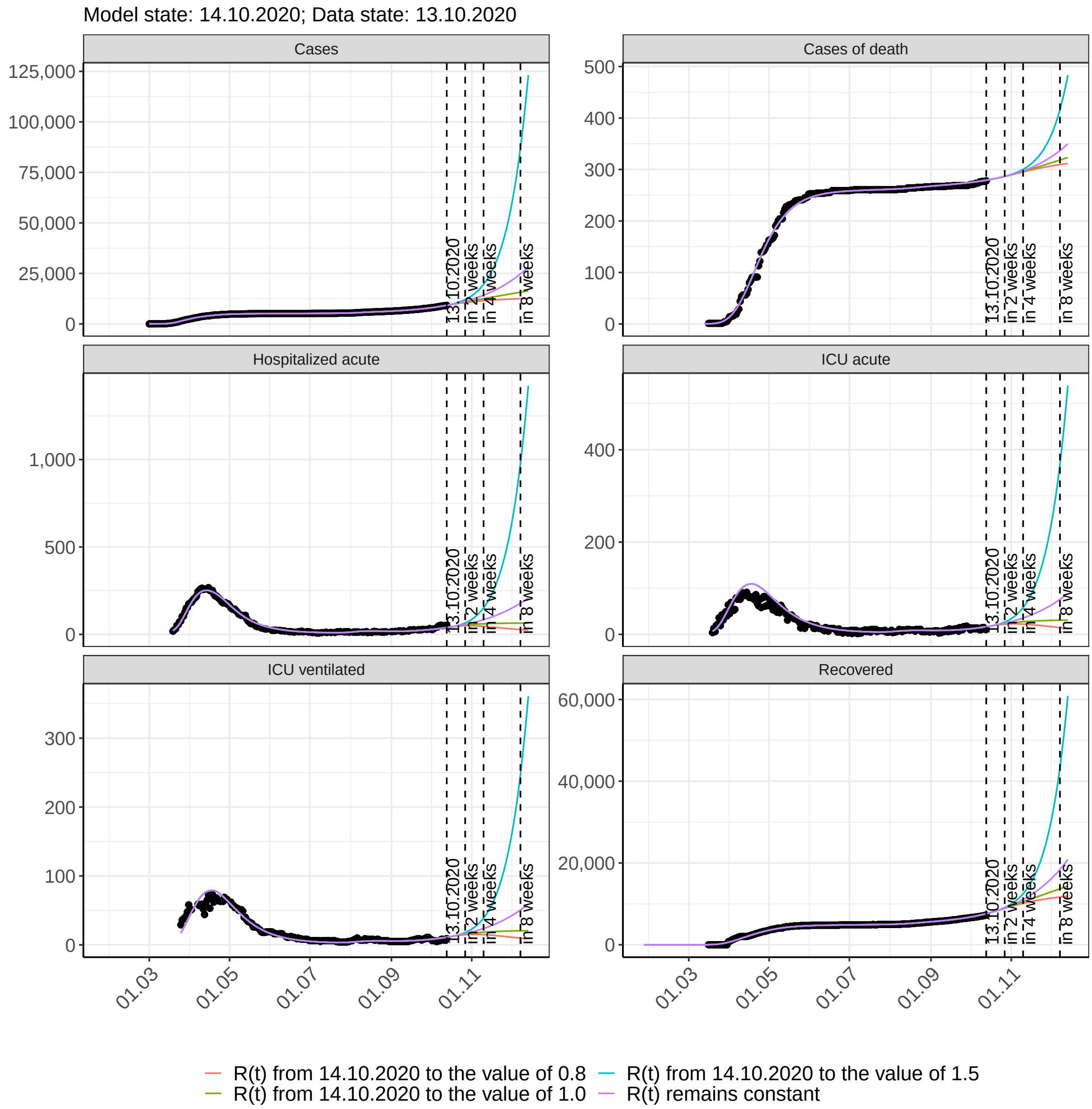



Figure 70: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Hamburg assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

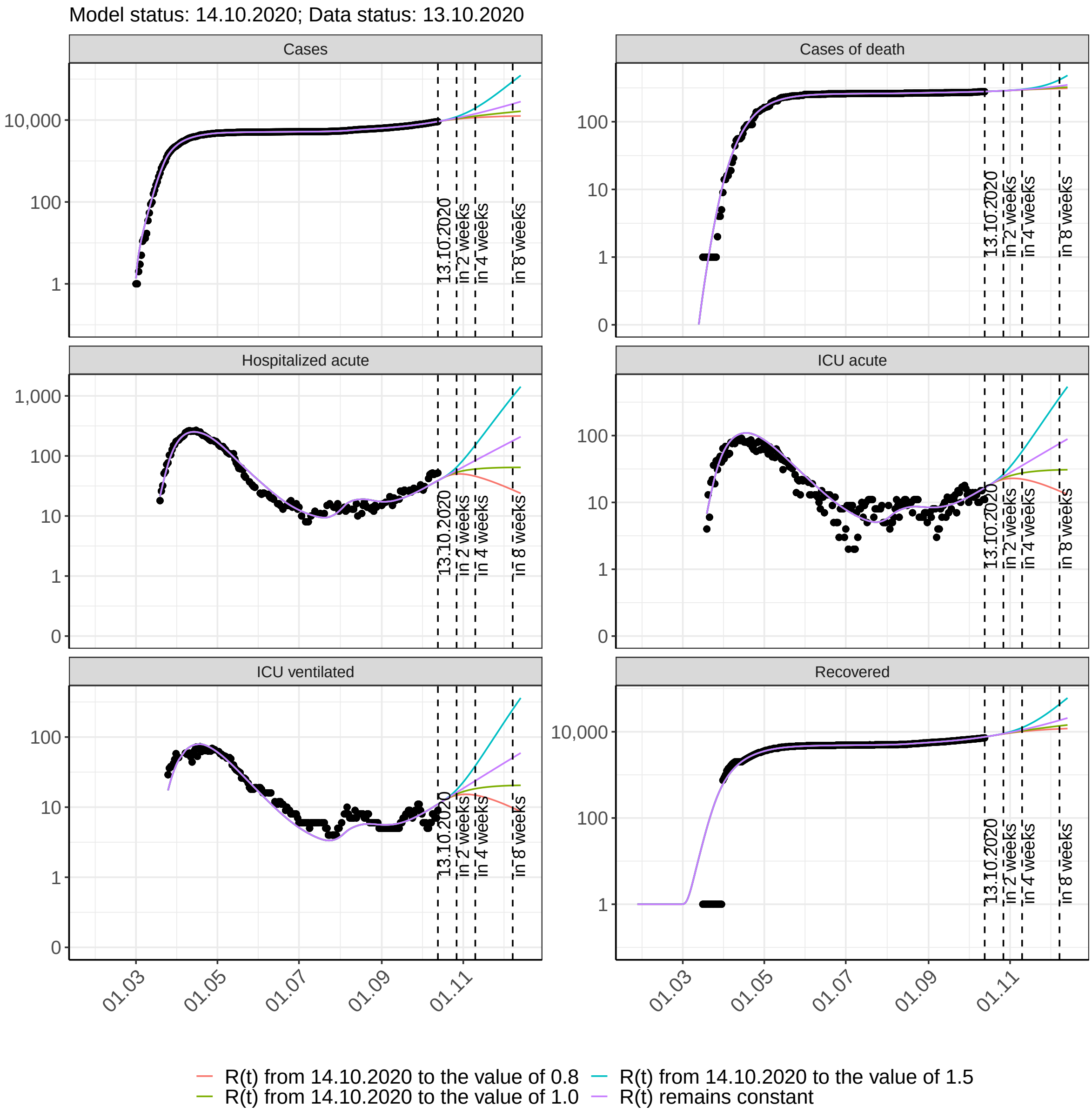



Figure 71: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Hamburg assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 72 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

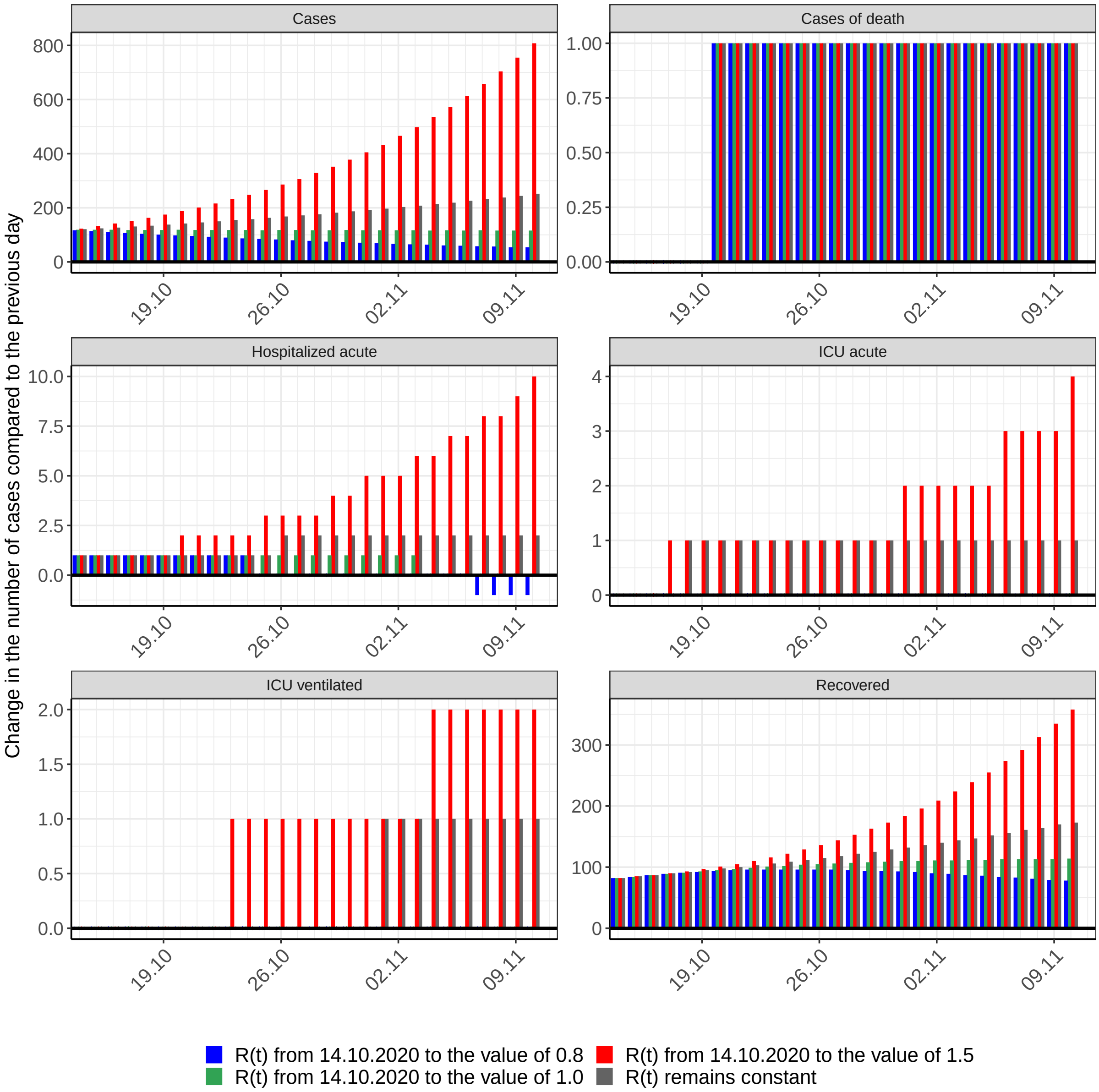



Figure 72: Simulation of daily new cases for the next 4 weeks - Hamburg

# 8 Hesse

## 8.1 Model description

Fig. 73 depicts the results of the modeling (lines) compared to the observed data (points) for Hesse on a linear (A) and semi-logarithmic (B) scale.

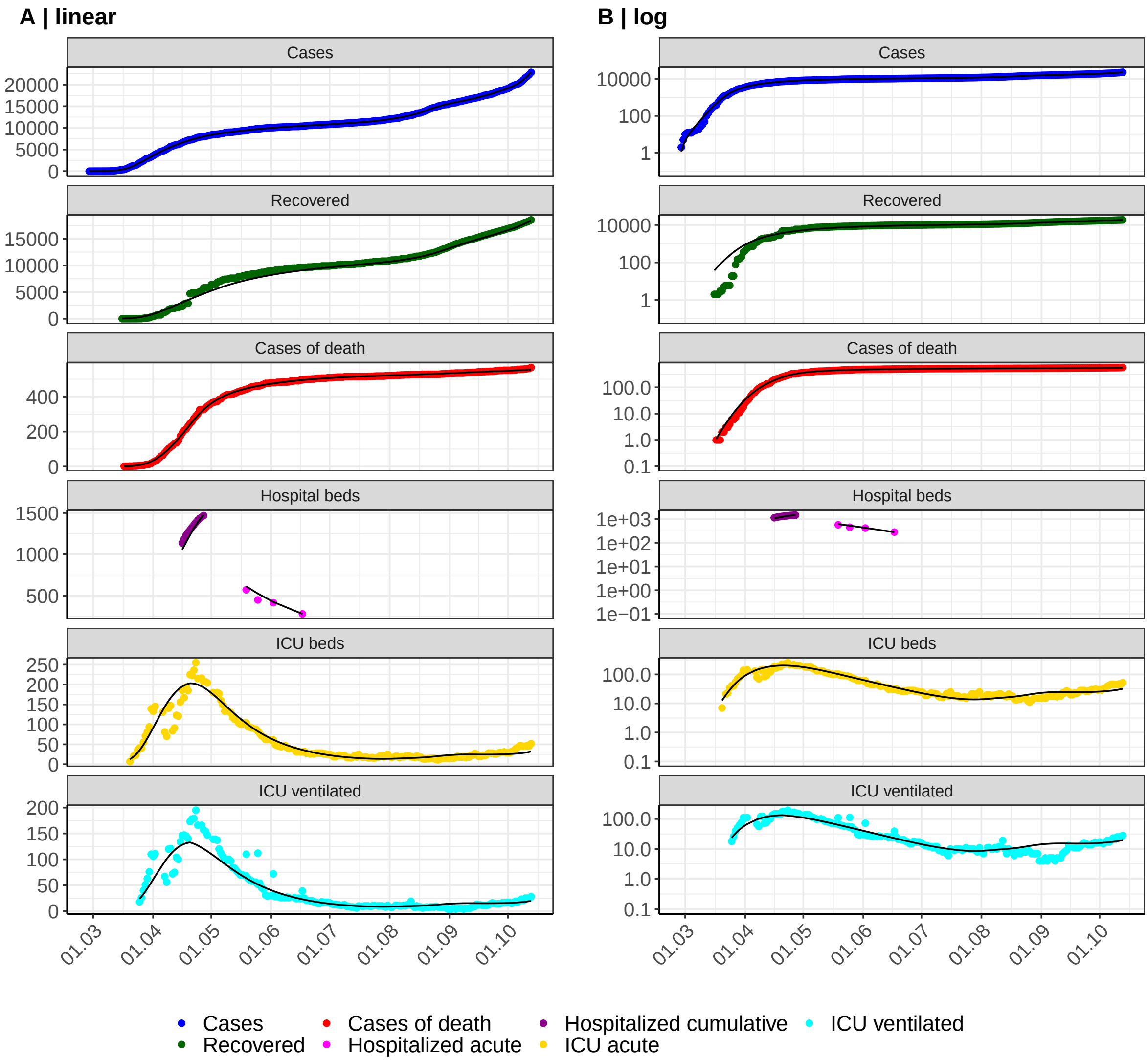



Figure 73: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Hesse. Points: reported data; lines: model description.

Fig. 74 shows the goodness-of-fit for Hesse. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

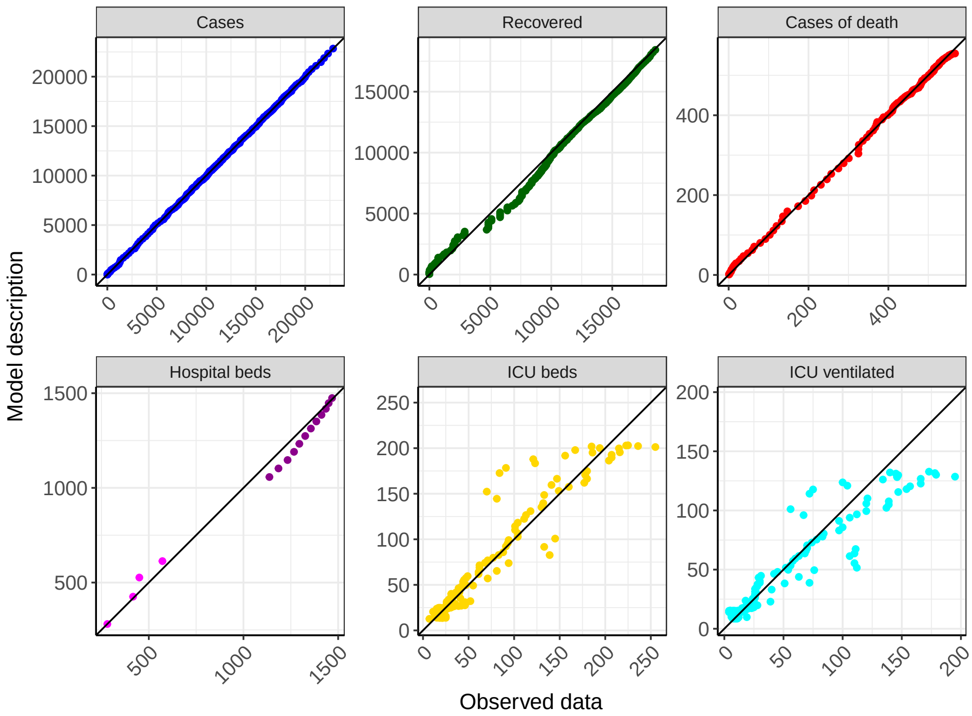



Figure 74: Goodness-of-fit plots for Hesse. Lines: lines of identity.

Fig. 75 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Hesse (red line) in comparison with the other federal states (grey lines).

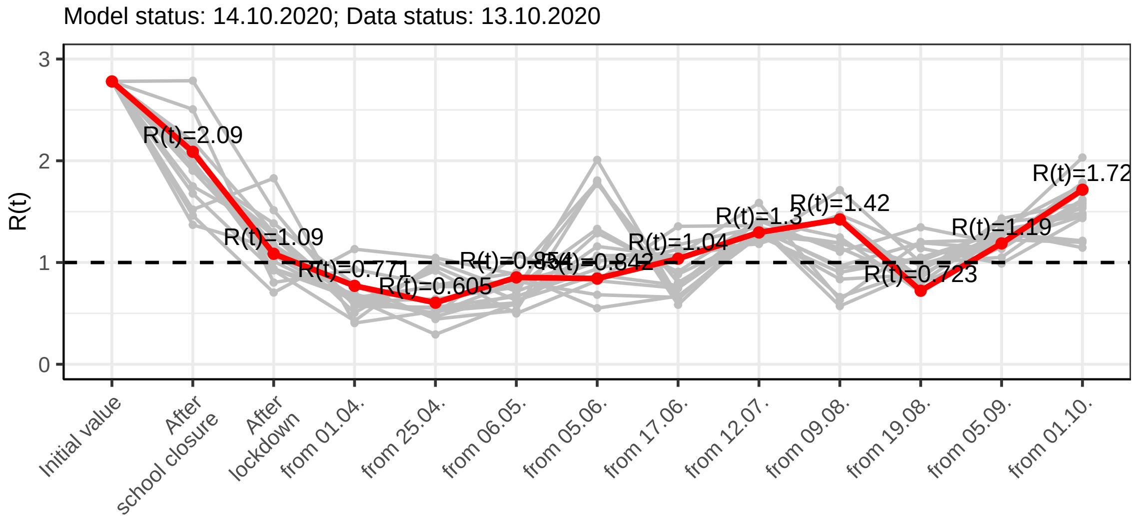



Figure 75: R(t) values before and after the NPIs for Hesse

Fig. 76 shows the R(t) estimated value for Hesse (red line) over time in comparison with the other federal states (grey lines).

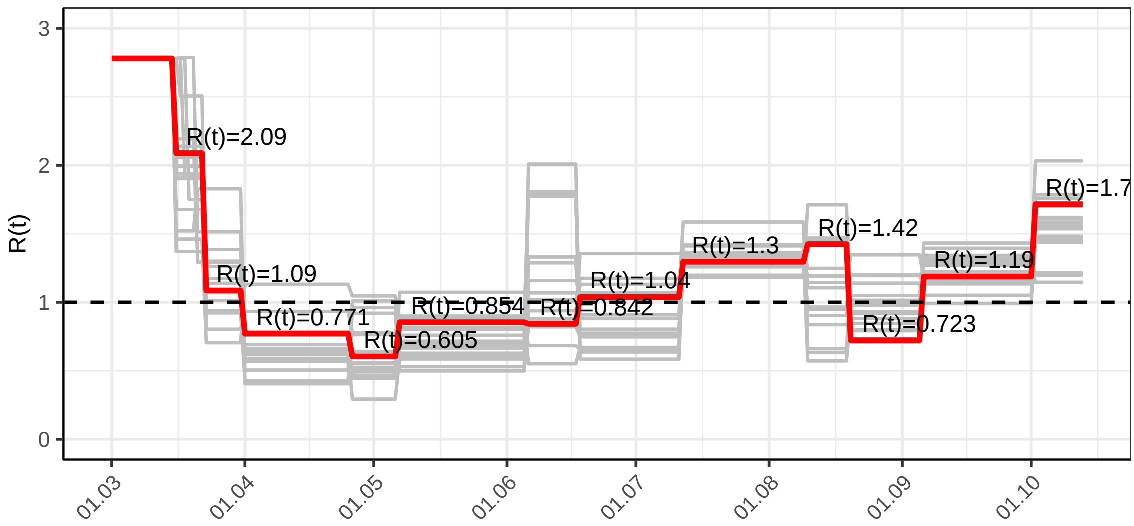



Figure 76: R(t) values over time for Hesse

Fig. 77 shows the changes in hospitalization and death rates for Hesse (red line) over time compared to the other states (grey lines).

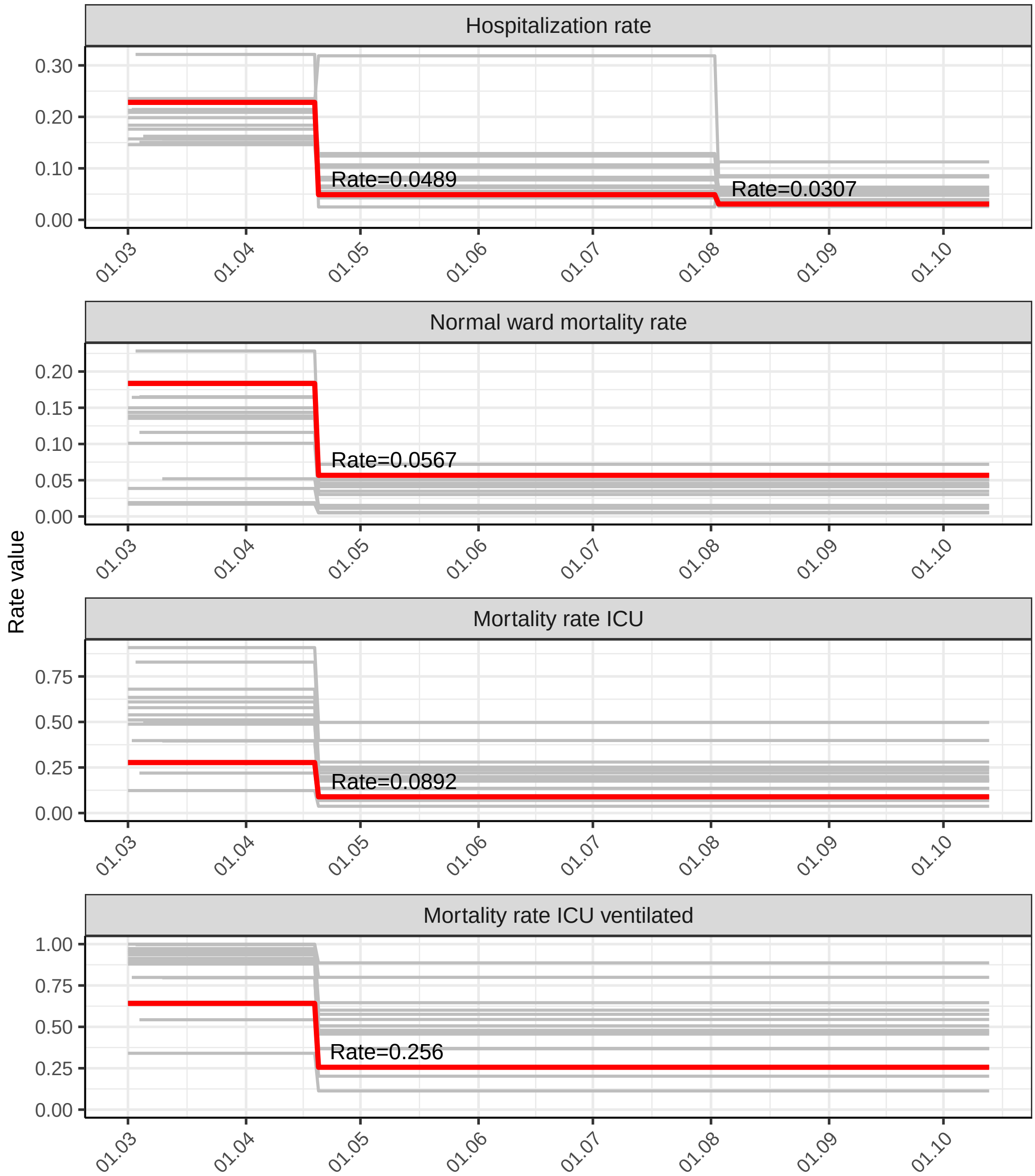



Figure 77: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Hesse

## 8.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.72)

Fig.78 and 79 depict the the model predictions for the next 4 weeks for Hesse on a linear (78) and a semi-logarithmic (79) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

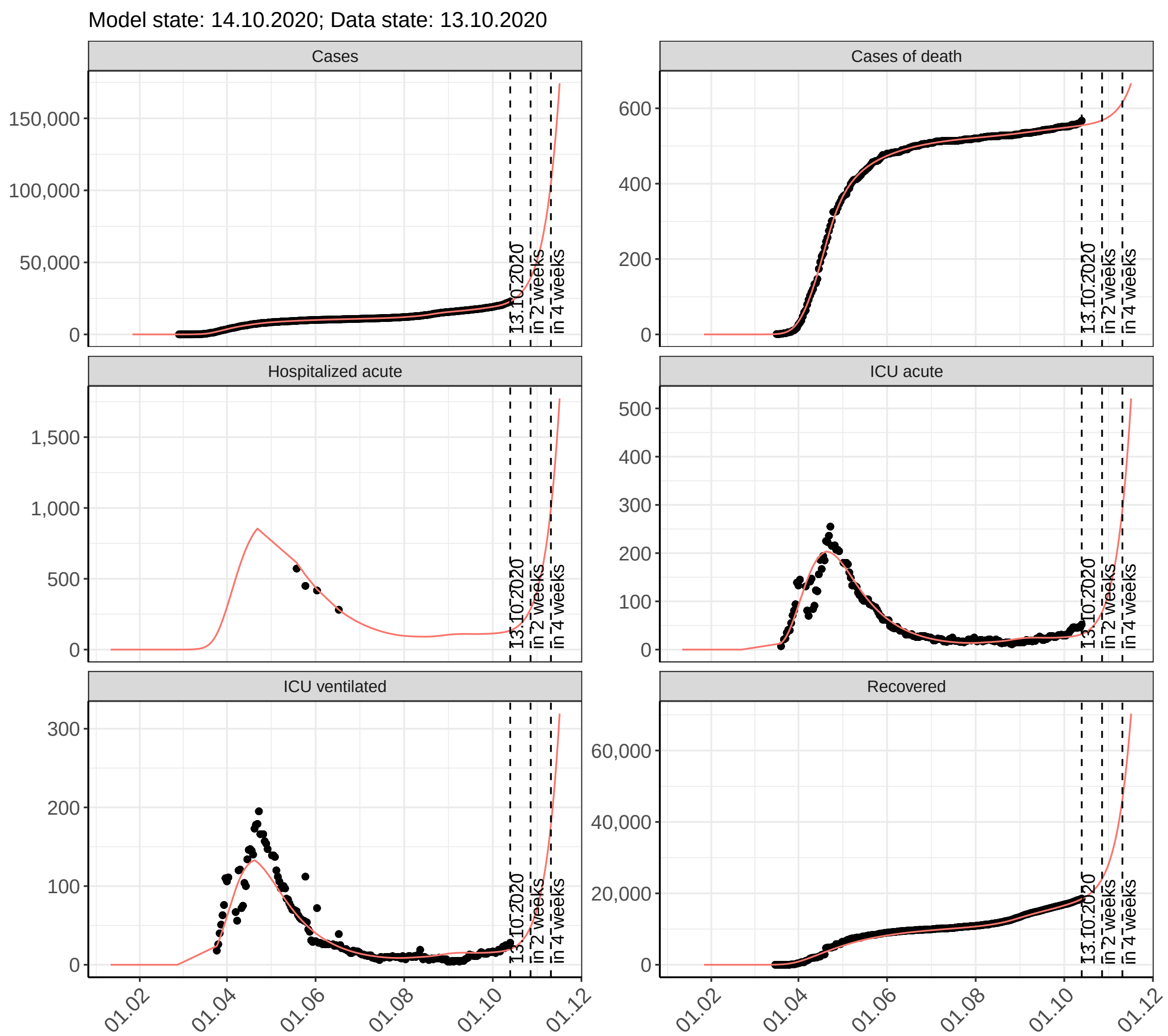



Figure 78: Representation of the model predictions for Hesse for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

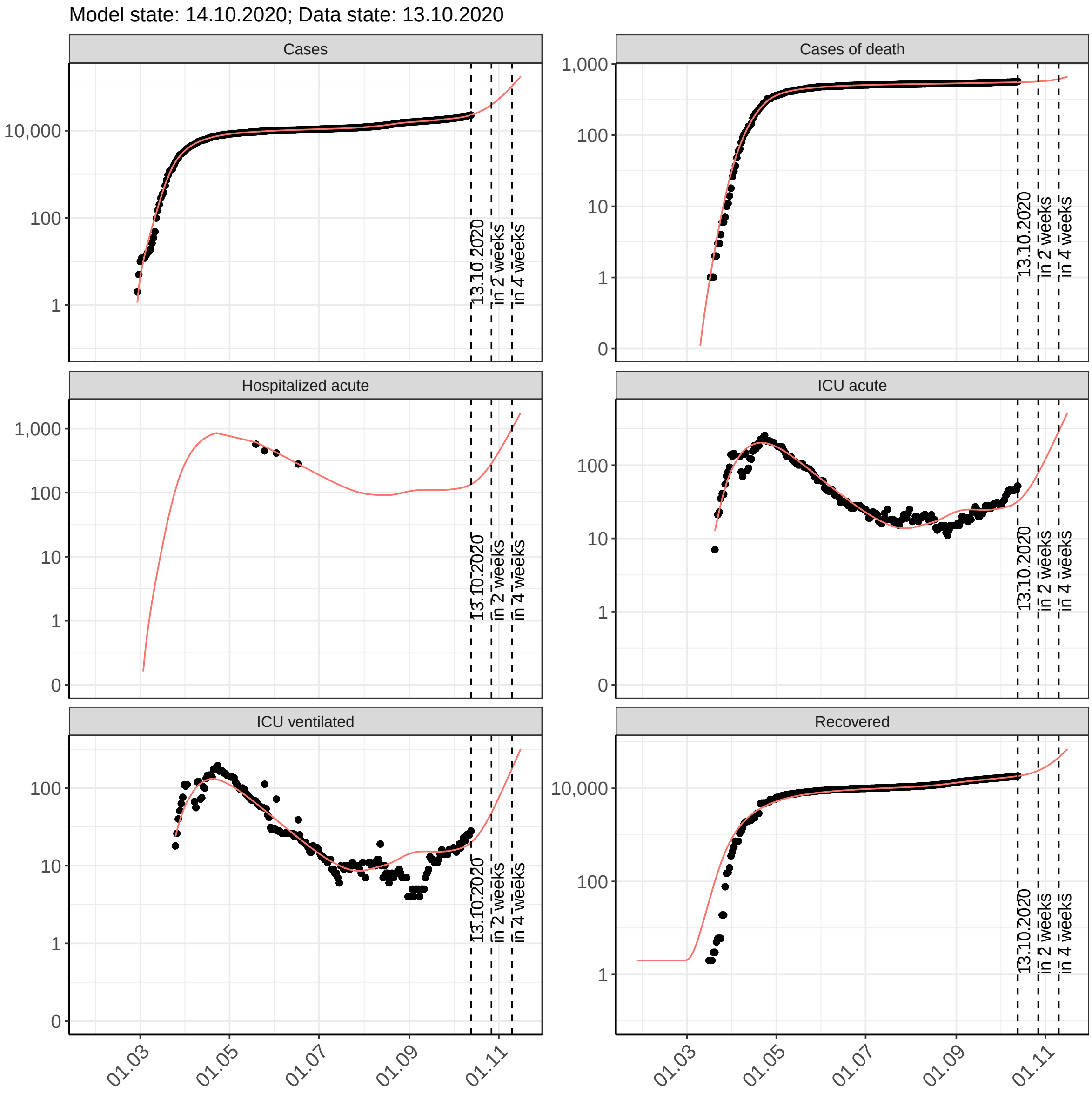



Figure 79: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Hesse for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.80 and 81 represent the model prediction for the next 8 weeks for Hesse on a linear (80) and a semi-logarithmic (81) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

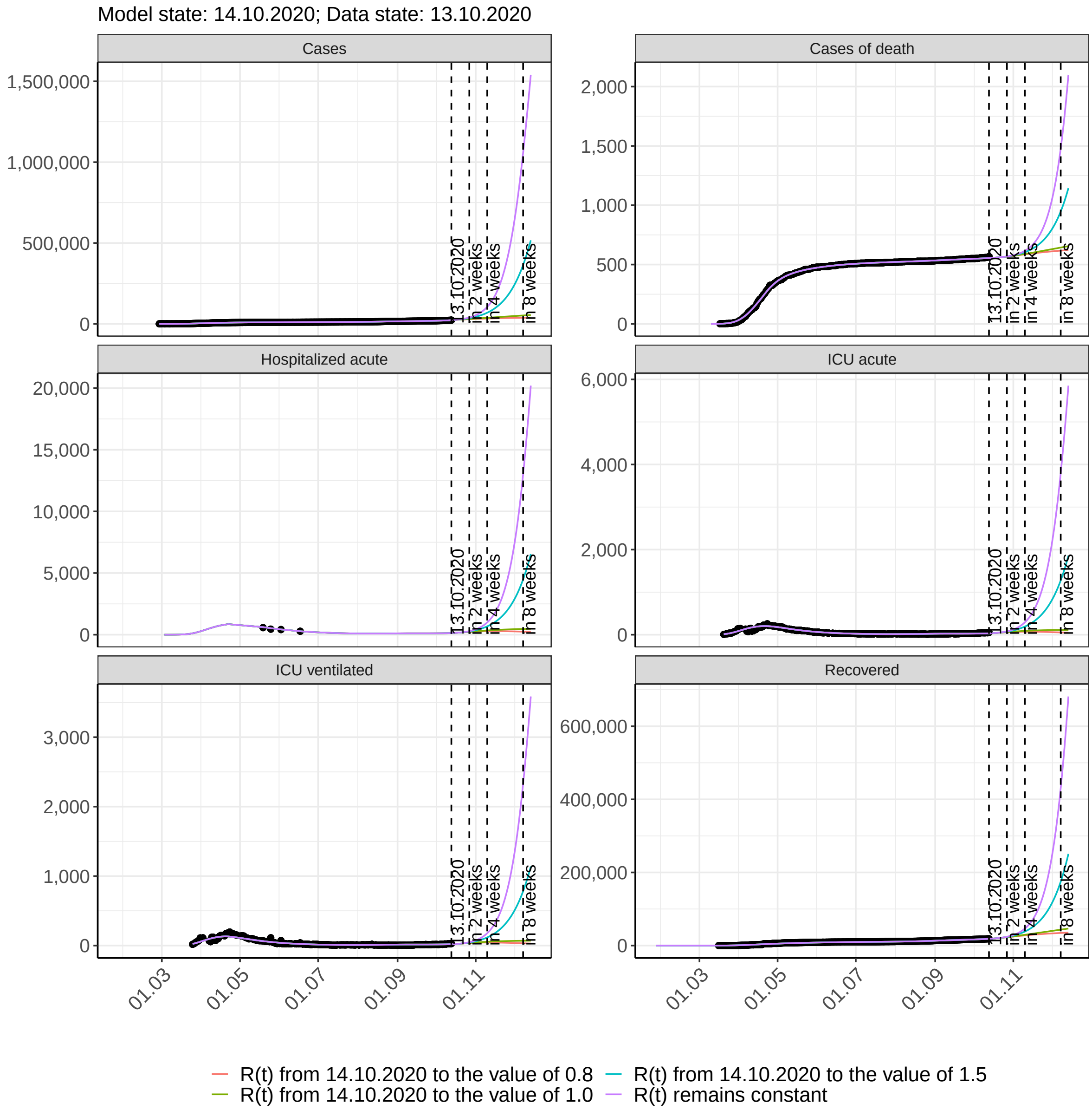



Figure 80: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Hesse assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

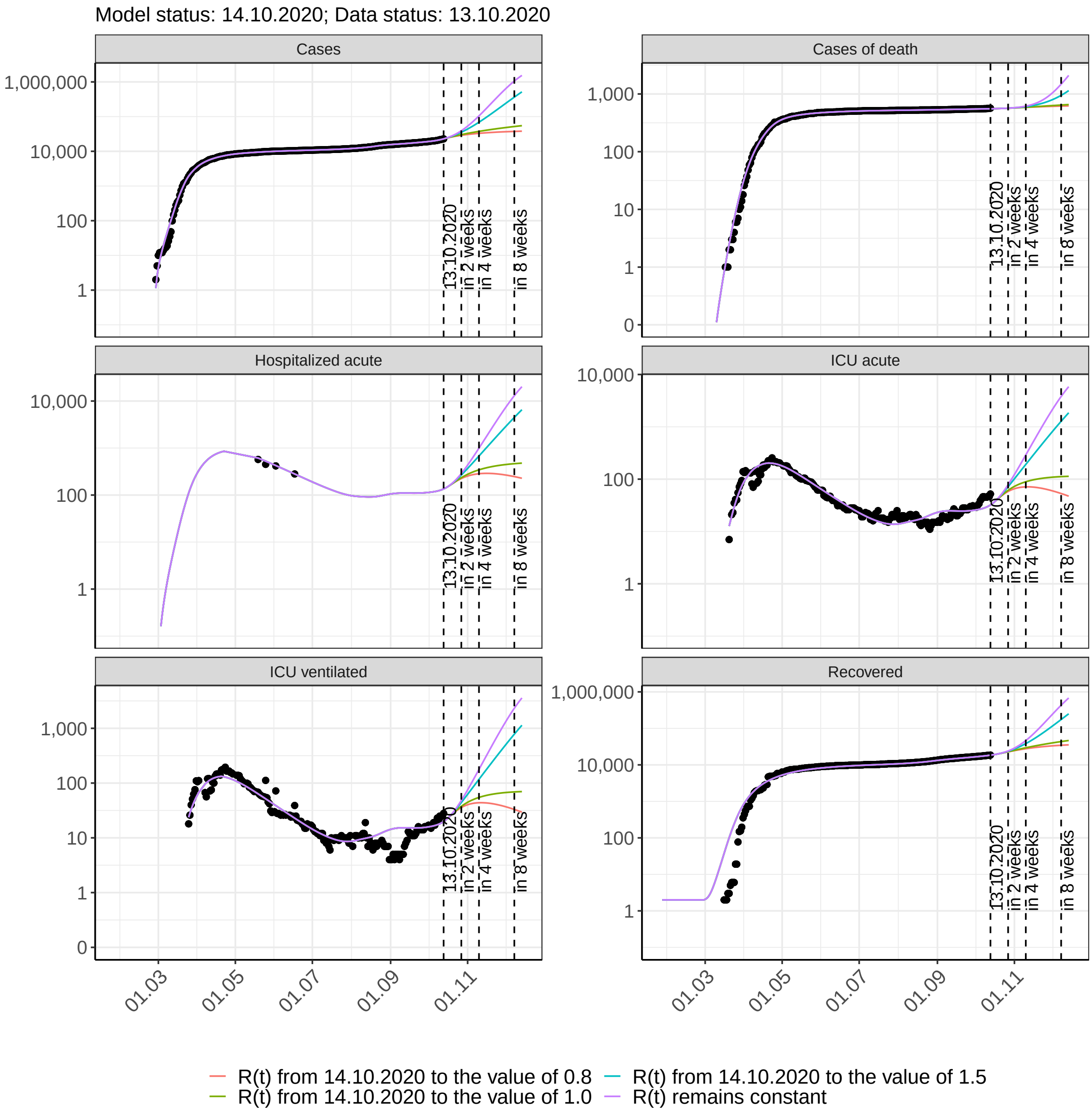



Figure 81: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Hesse assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 82 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

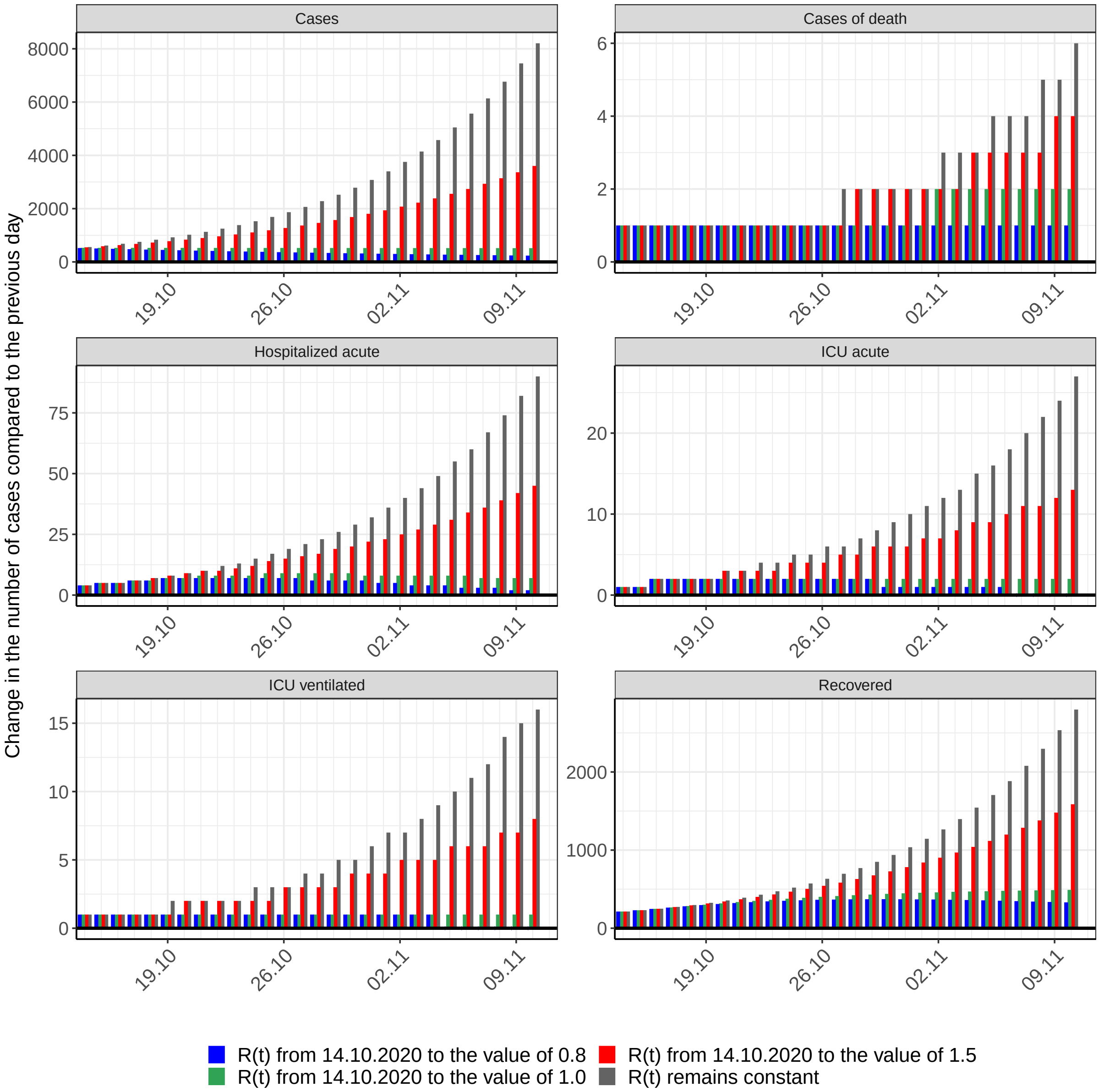



Figure 82: Simulation of daily new cases for the next 4 weeks - Hesse

# 9 Mecklenburg-Vorpommern

## 9.1 Model description

Fig. 83 depicts the results of the modeling (lines) compared to the observed data (points) for Mecklenburg-Vorpommern on a linear (A) and semi-logarithmic (B) scale.

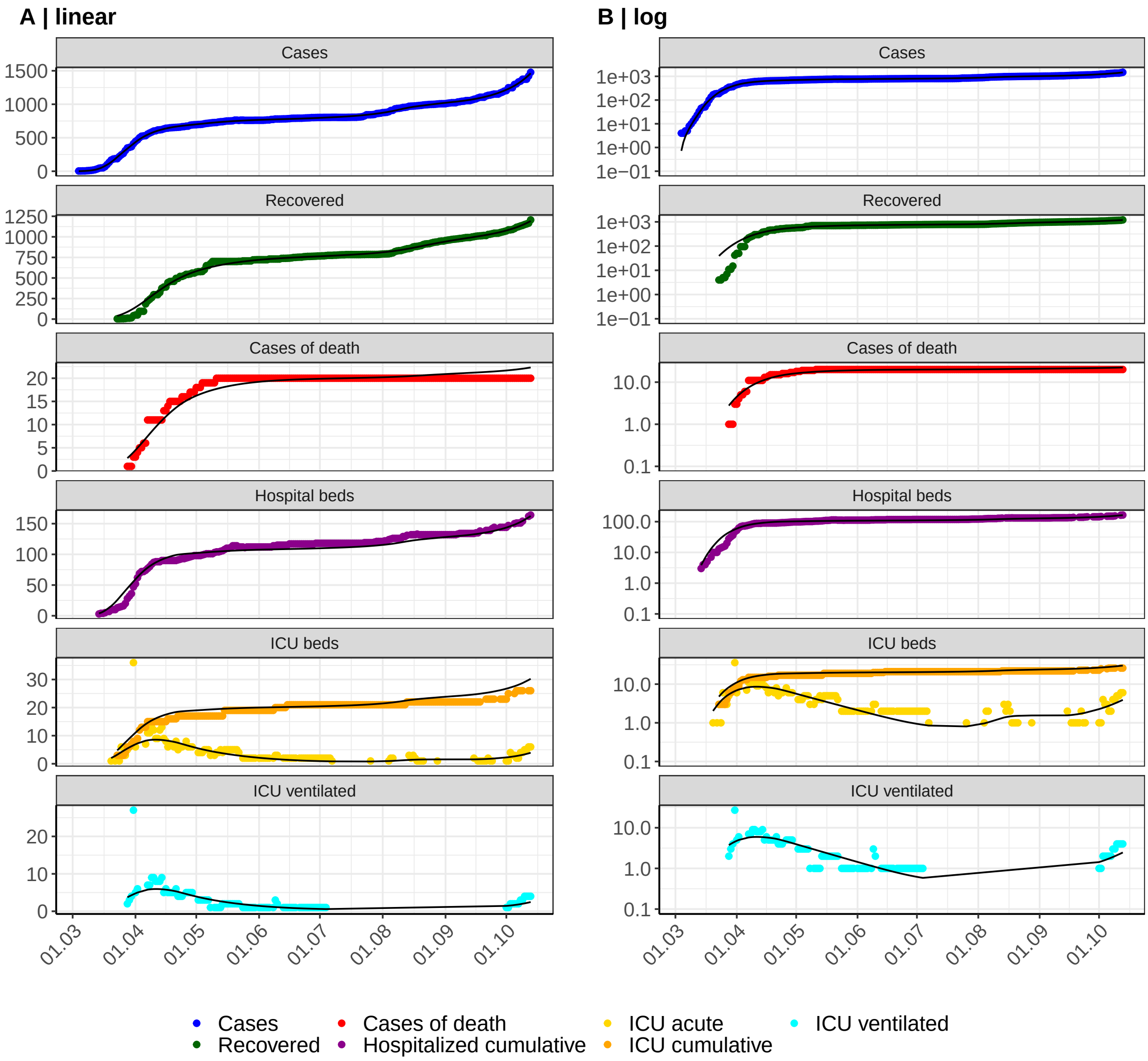



Figure 83: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Mecklenburg-Vorpommern. Points: reported data; lines: model description.

Fig. 84 shows the goodness-of-fit for Mecklenburg-Vorpommern. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

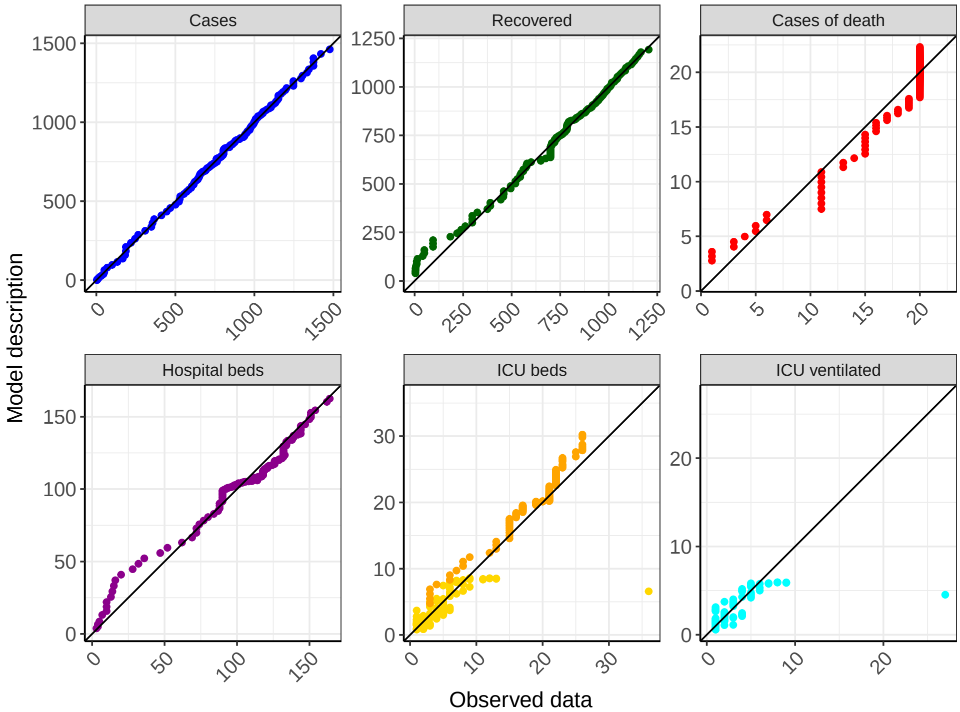



Figure 84: Goodness-of-fit plots for Mecklenburg-Vorpommern. Lines: lines of identity.

Fig. 85 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Mecklenburg-Vorpommern (red line) in comparison with the other federal states (grey lines).

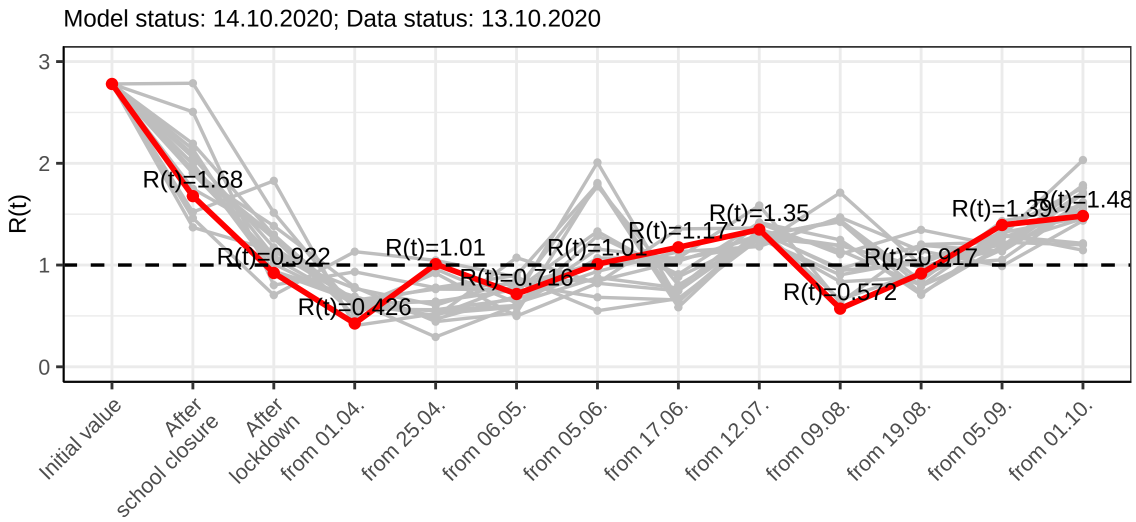



Figure 85: R(t) values before and after the NPIs for Mecklenburg-Vorpommern

Fig. 86 shows the R(t) estimated value for Mecklenburg-Vorpommern (red line) over time in comparison with the other federal states (grey lines).

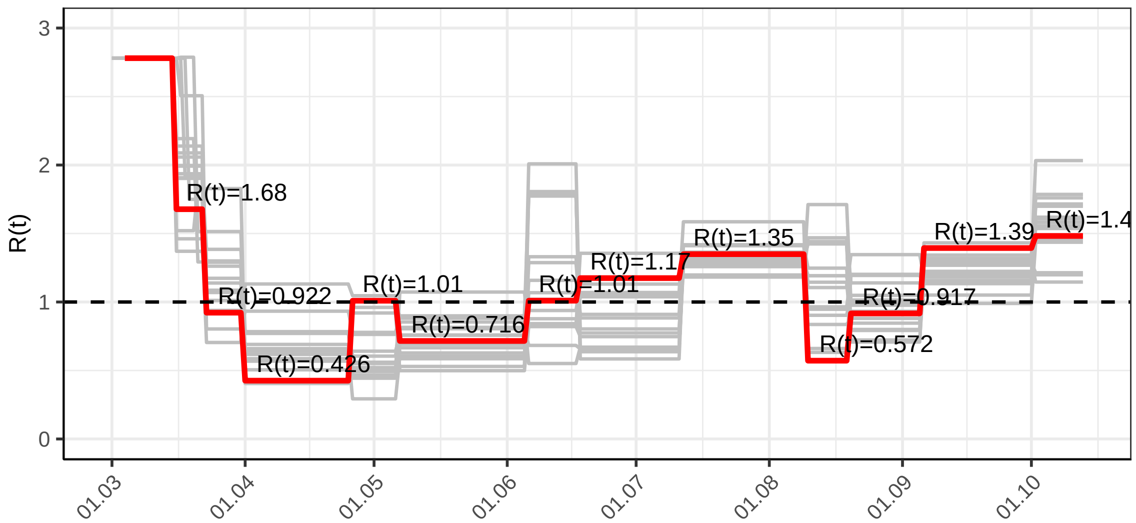



Figure 86: R(t) values over time for Mecklenburg-Vorpommern

Fig. 87 shows the changes in hospitalization and death rates for Mecklenburg-Vorpommern (red line) over time compared to the other states (grey lines).

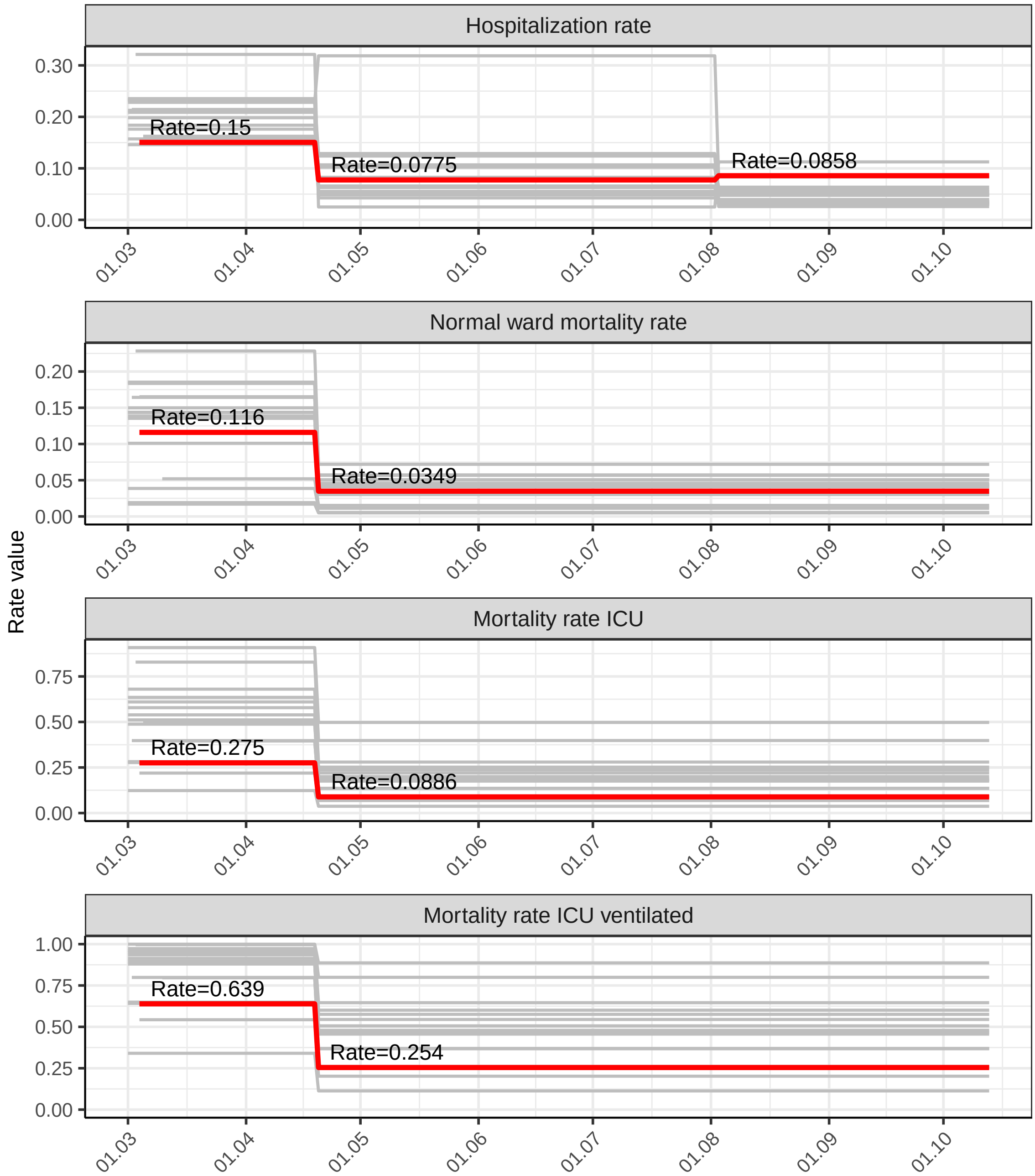



Figure 87: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Mecklenburg-Vorpommern

## 9.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.48)

Fig.88 and 89 depict the the model predictions for the next 4 weeks for Mecklenburg-Vorpommern on a linear (88) and a semi-logarithmic (89) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

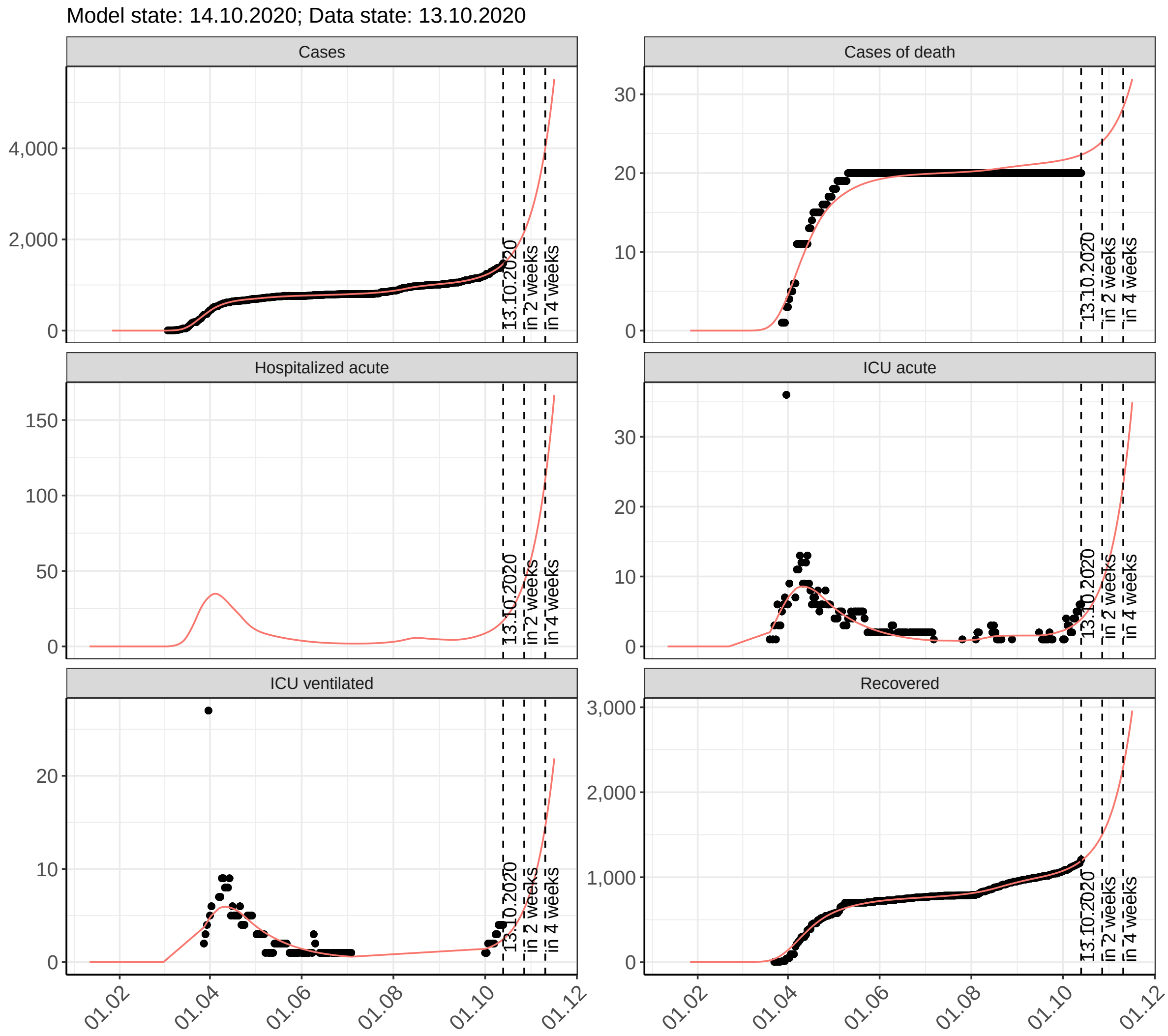



Figure 88: Representation of the model predictions for Mecklenburg-Vorpommern for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

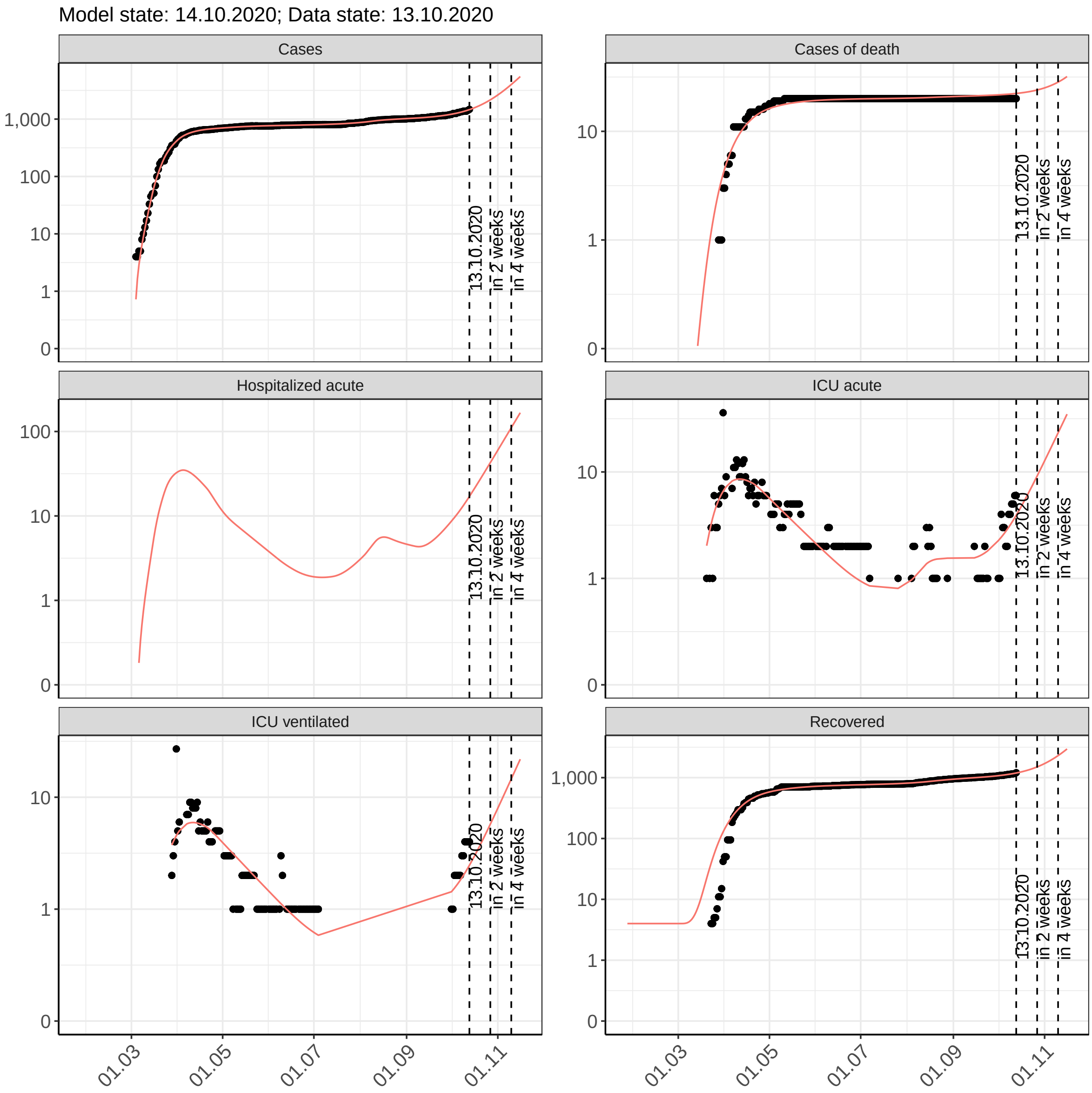



Figure 89: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Mecklenburg-Vorpommern for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.90 and 91 represent the model prediction for the next 8 weeks for Mecklenburg-Vorpommern on a linear (90) and a semi-logarithmic (91) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

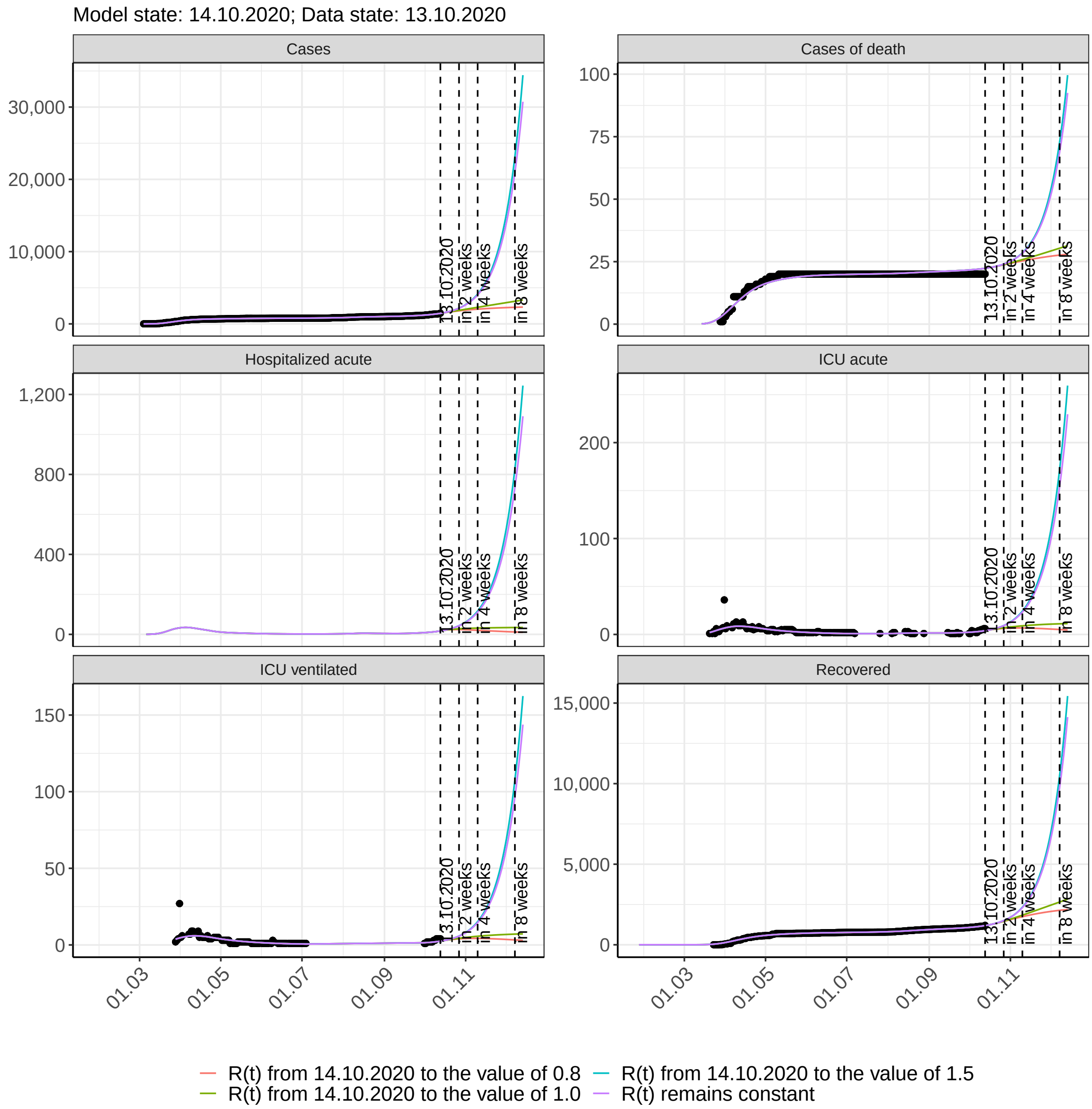



Figure 90: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Mecklenburg-Vorpommern assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

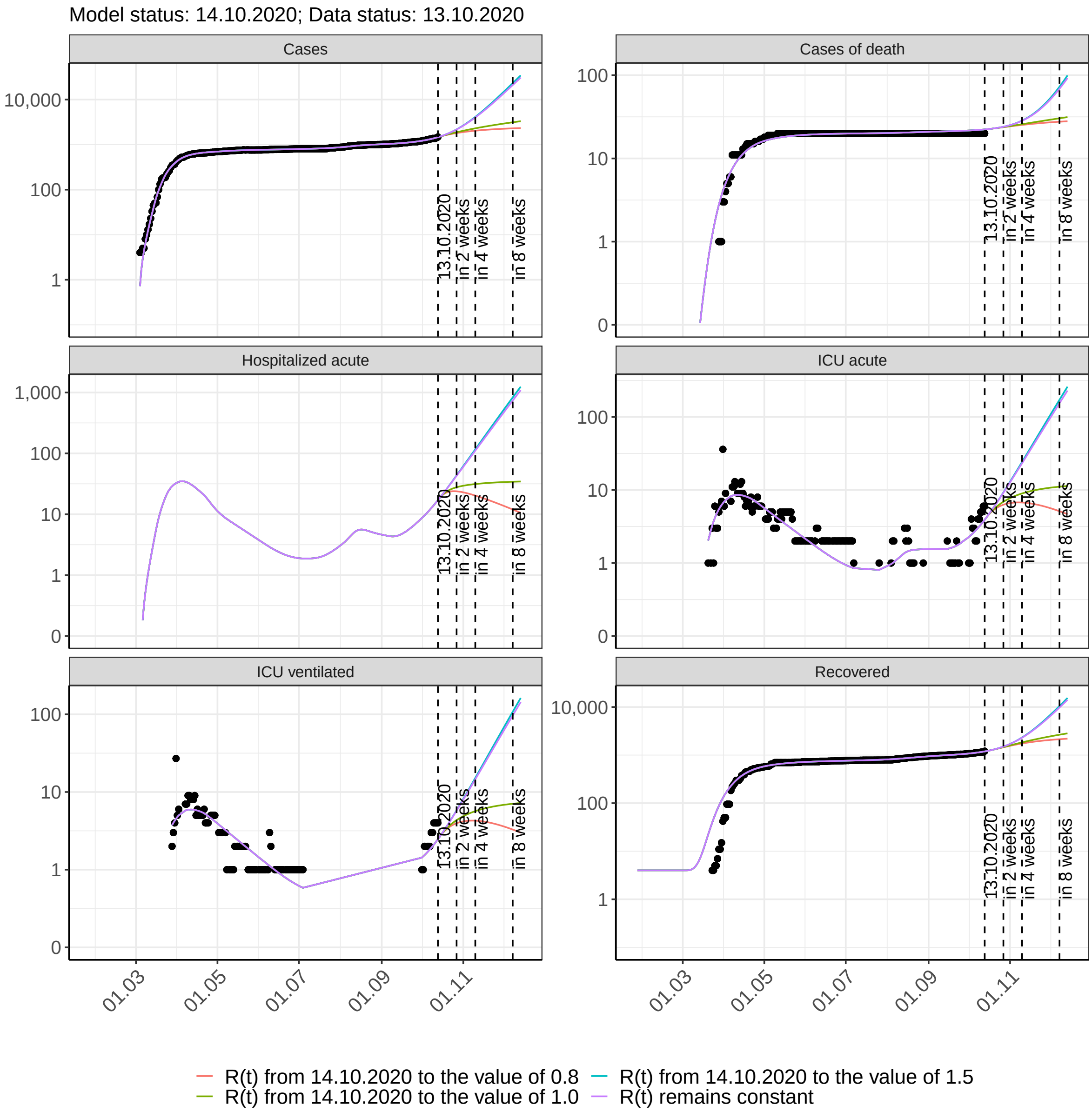



Figure 91: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Mecklenburg-Vorpommern assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 92 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

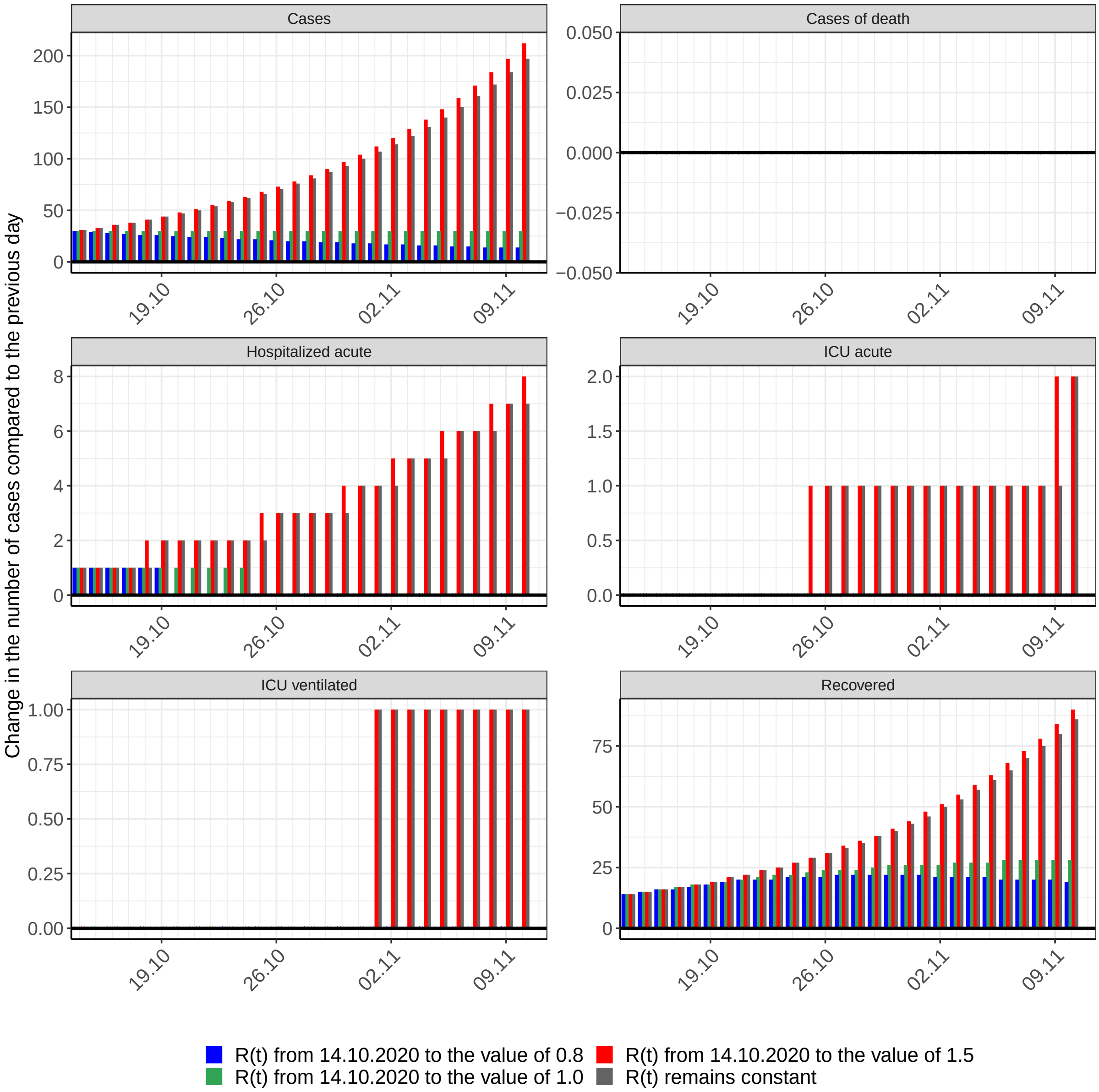



Figure 92: Simulation of daily new cases for the next 4 weeks - Mecklenburg-Vorpommern

# 10 Lower Saxony

## 10.1 Model description

Fig. 93 depicts the results of the modeling (lines) compared to the observed data (points) for Lower Saxony on a linear (A) and semi-logarithmic (B) scale.

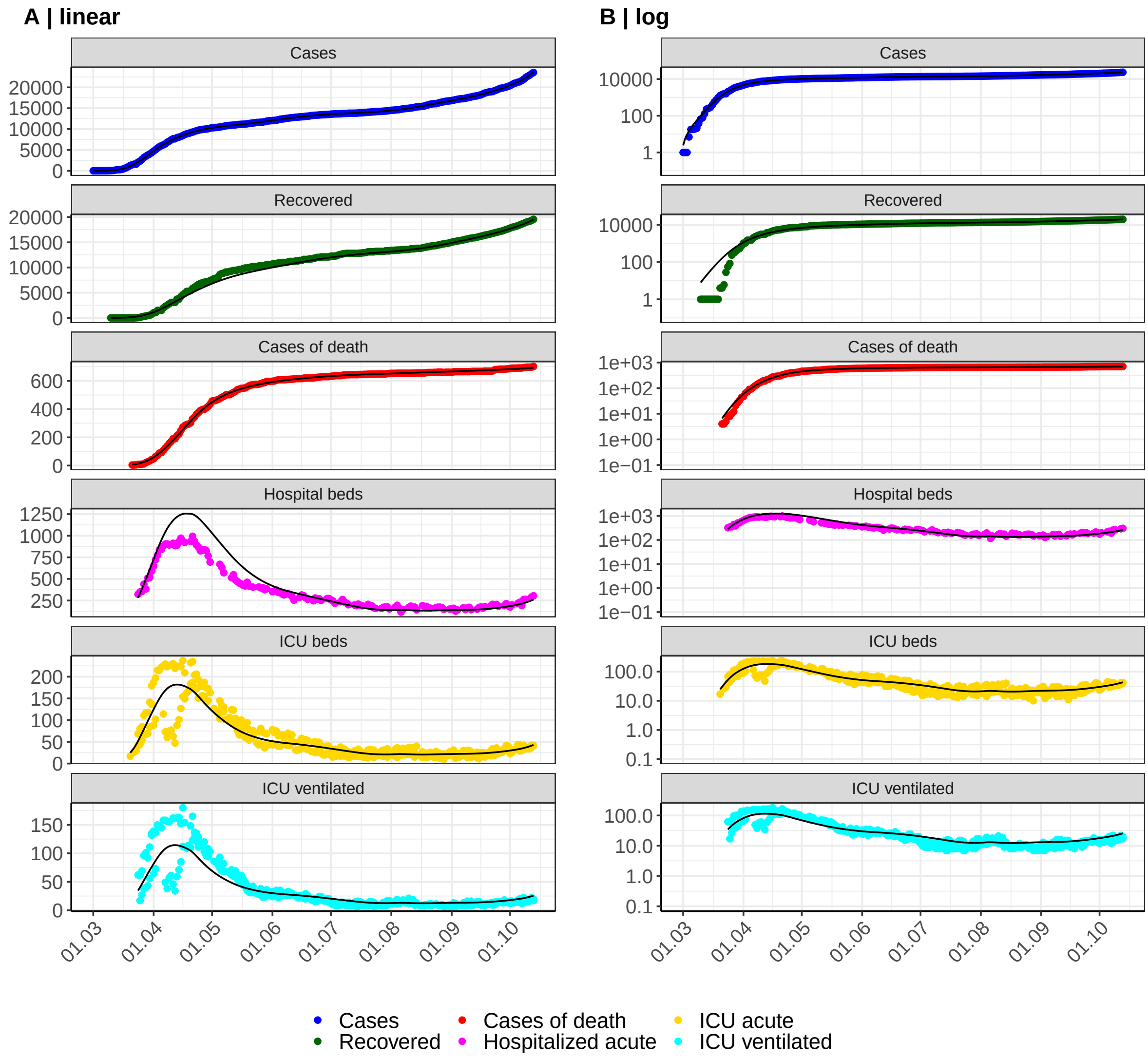



Figure 93: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Lower Saxony. Points: reported data; lines: model description.

Fig. 94 shows the goodness-of-fit for Lower Saxony. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

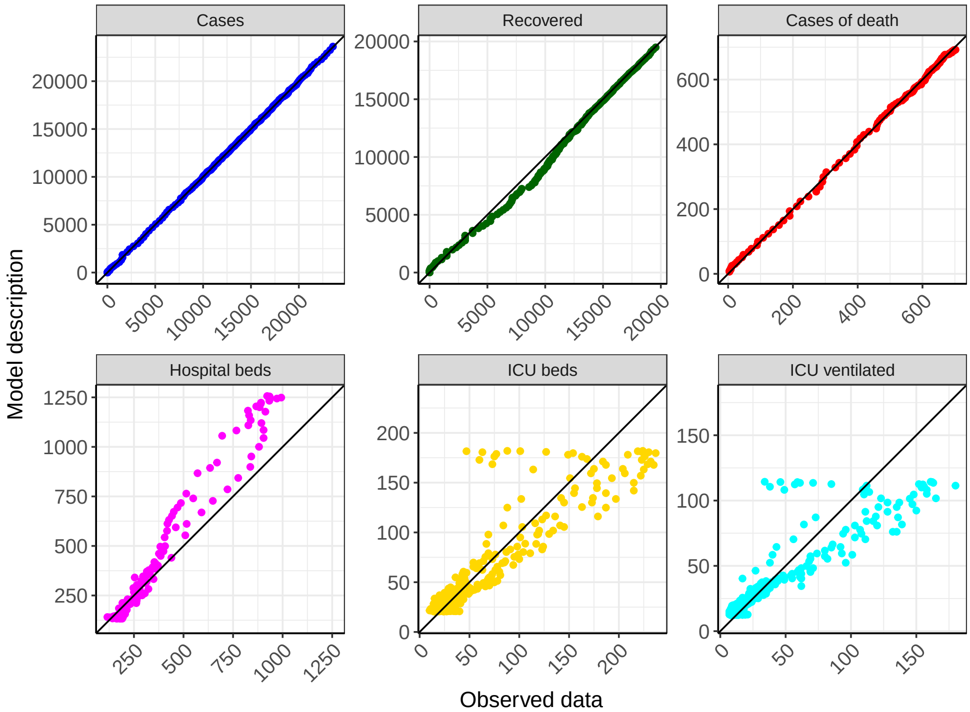



Figure 94: Goodness-of-fit plots for Lower Saxony. Lines: lines of identity.

Fig. 95 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Lower Saxony (red line) in comparison with the other federal states (grey lines).

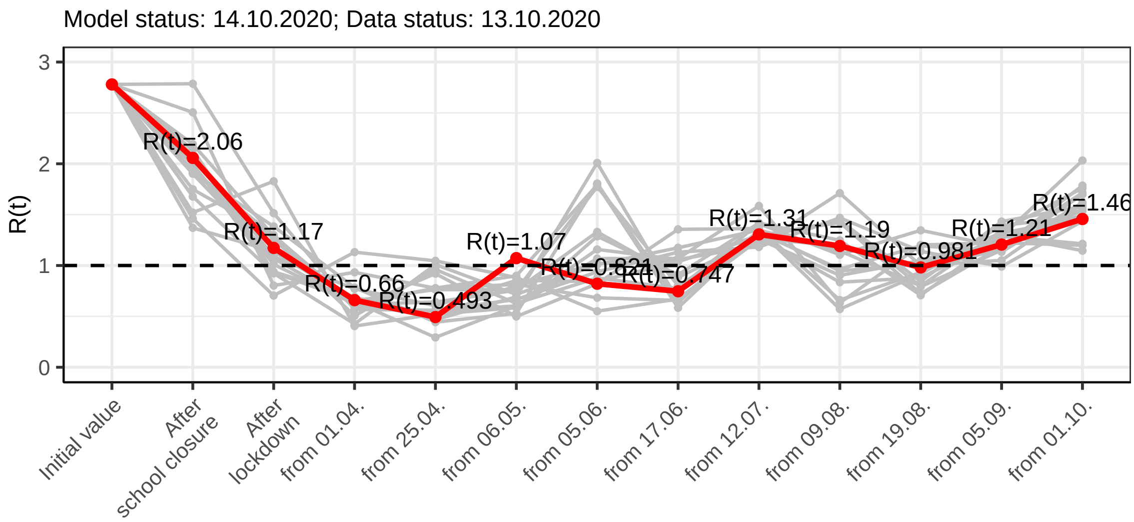



Figure 95: R(t) values before and after the NPIs for Lower Saxony

Fig. 96 shows the R(t) estimated value for Lower Saxony (red line) over time in comparison with the other federal states (grey lines).

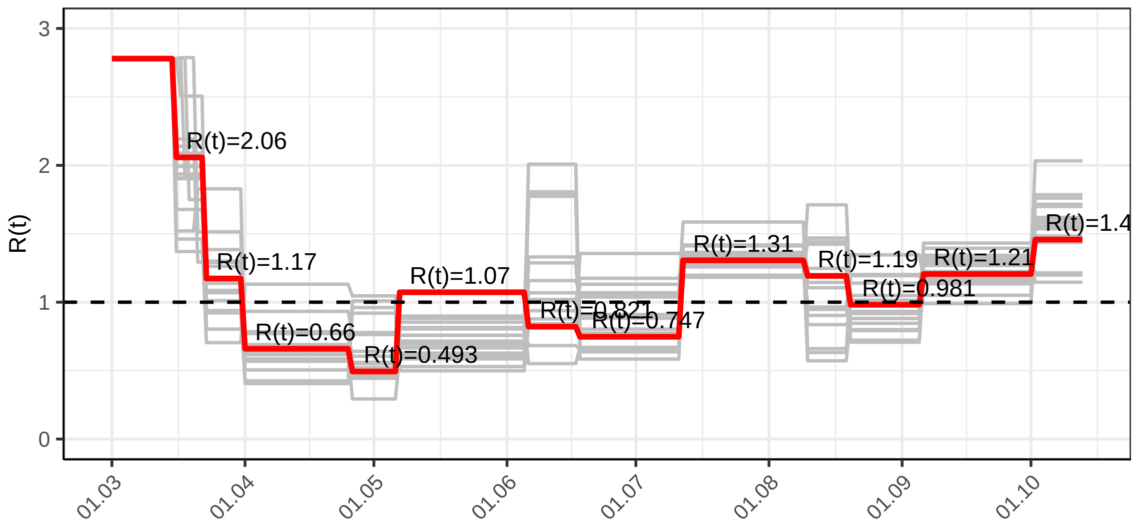



Figure 96: R(t) values over time for Lower Saxony

Fig. 97 shows the changes in hospitalization and death rates for Lower Saxony (red line) over time compared to the other states (grey lines).

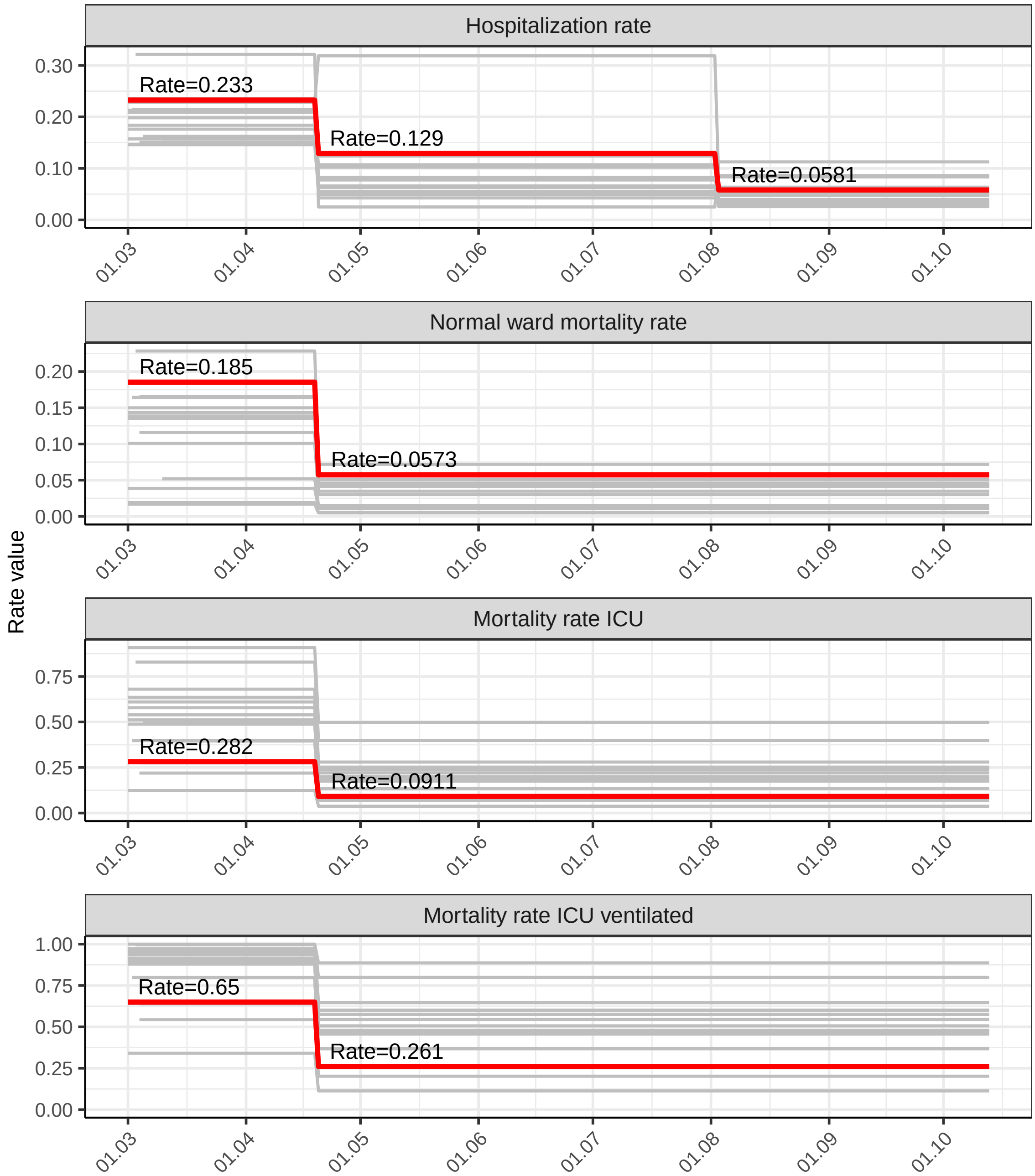



Figure 97: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Lower Saxony

## 10.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.46)

Fig.98 and 99 depict the the model predictions for the next 4 weeks for Lower Saxony on a linear (98) and a semi-logarithmic (99) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

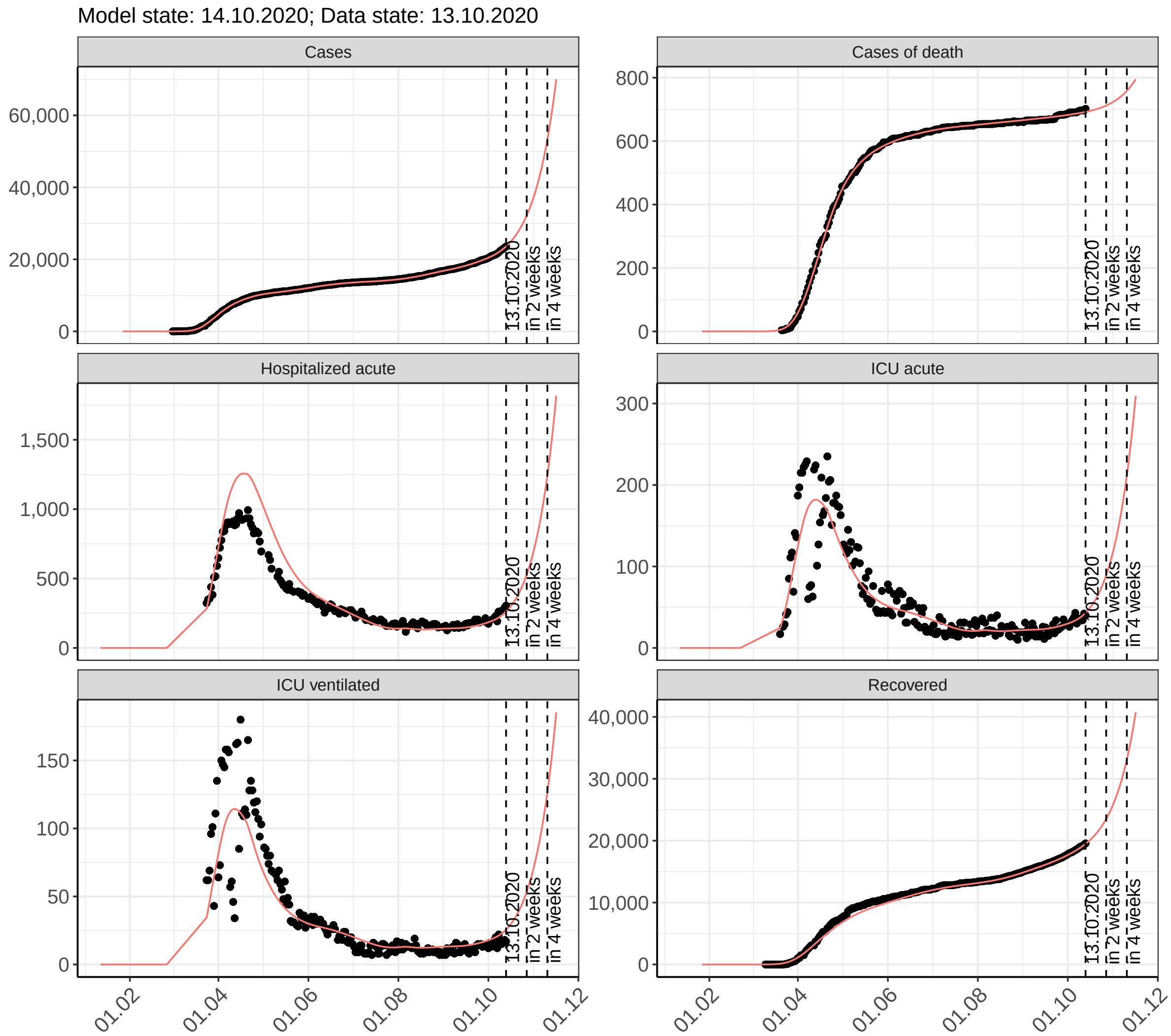



Figure 98: Representation of the model predictions for Lower Saxony for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

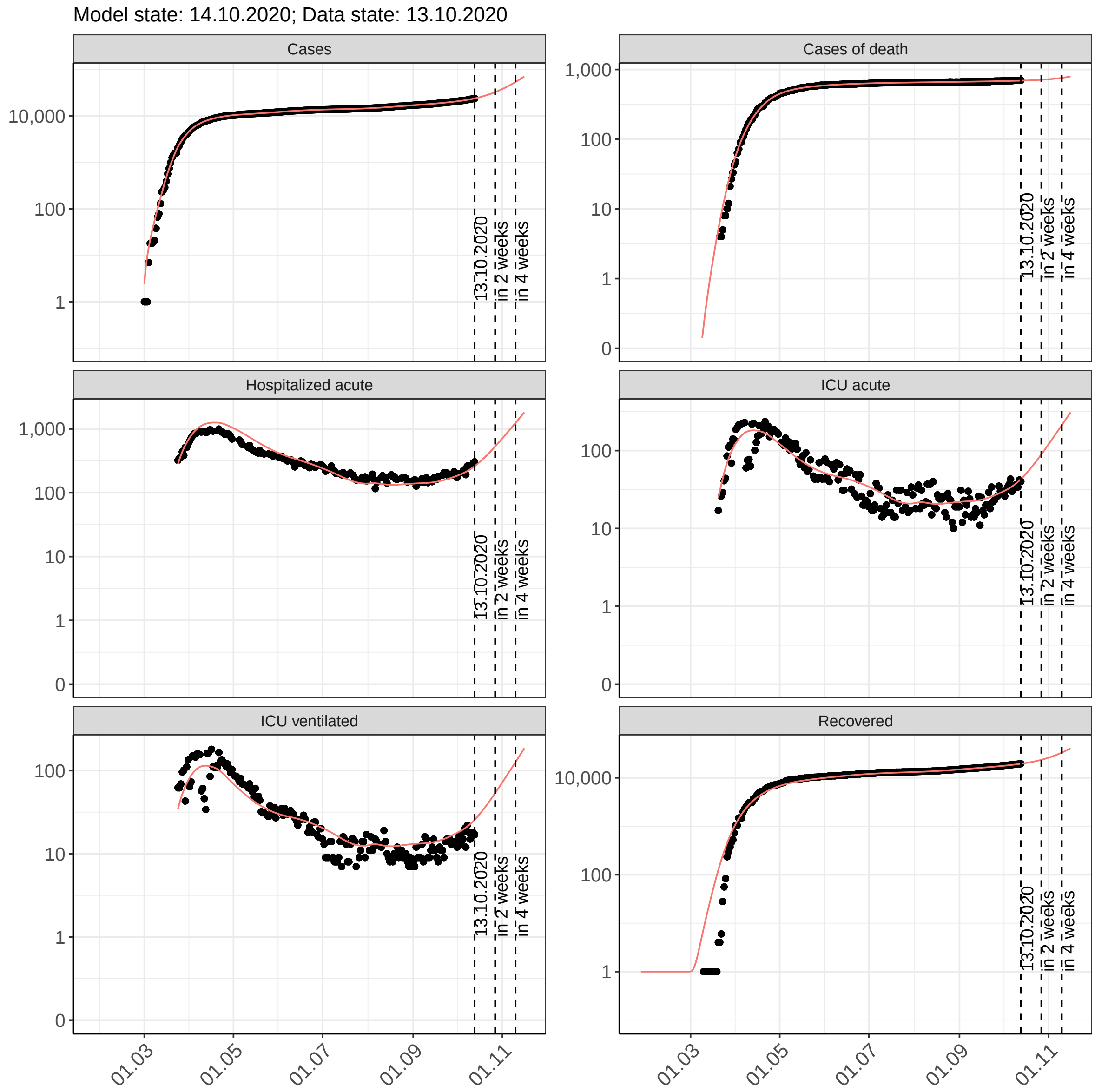



Figure 99: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Lower Saxony for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.100 and 101 represent the model prediction for the next 8 weeks for Lower Saxony on a linear (100) and a semi-logarithmic (101) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

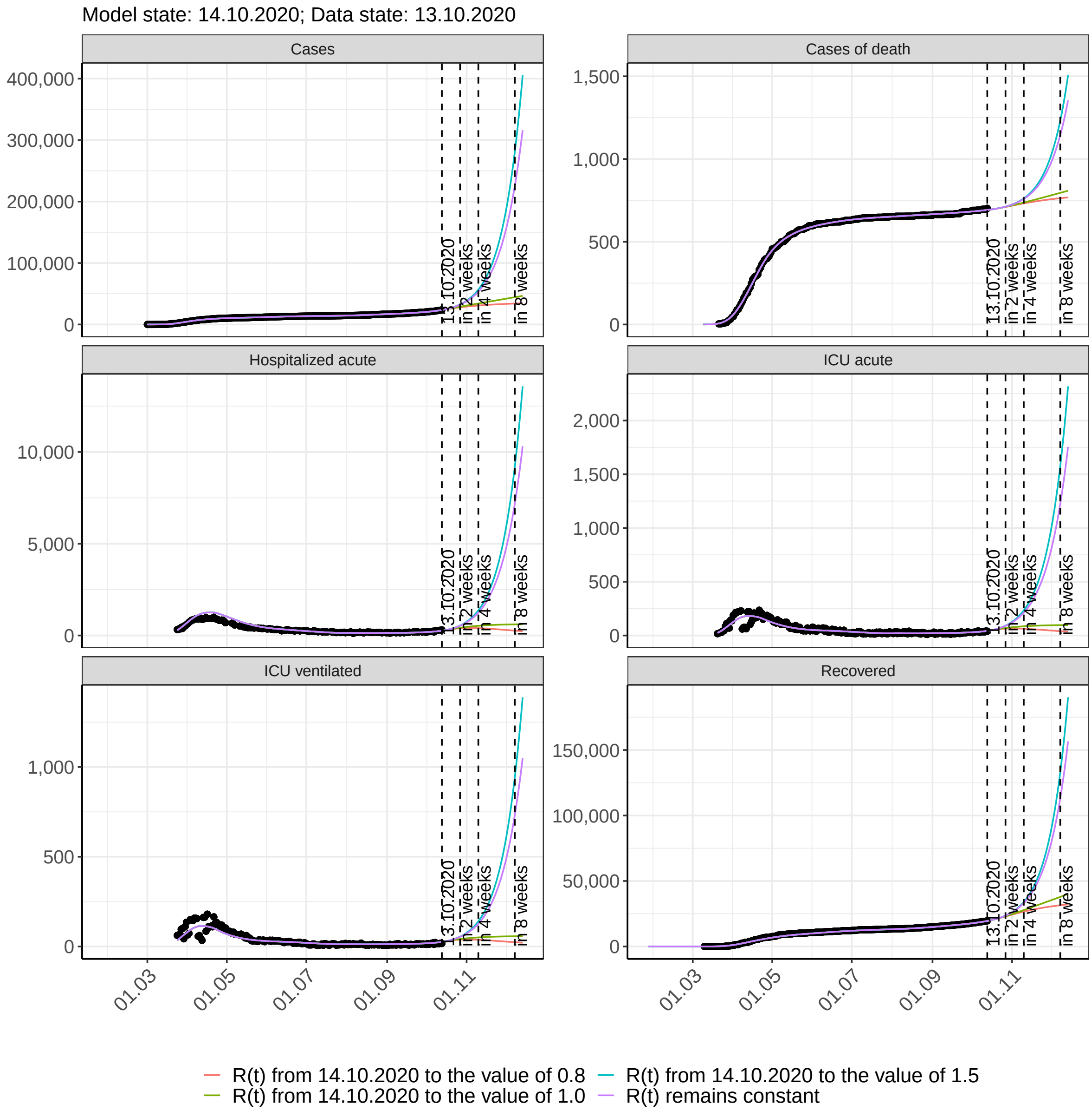



Figure 100: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Lower Saxony assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

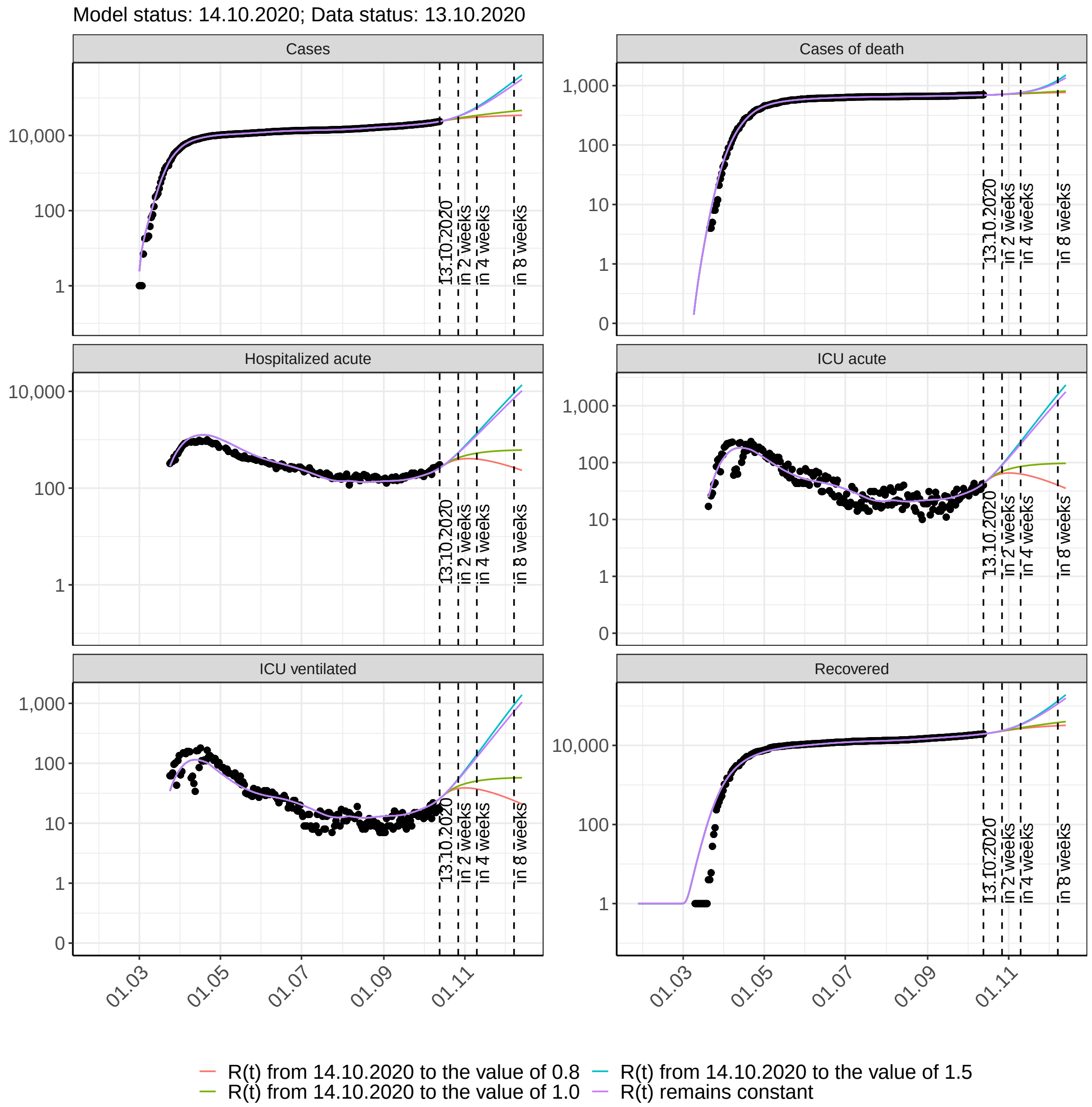



Figure 101: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Lower Saxony assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

**Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020**

Fig. 102 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

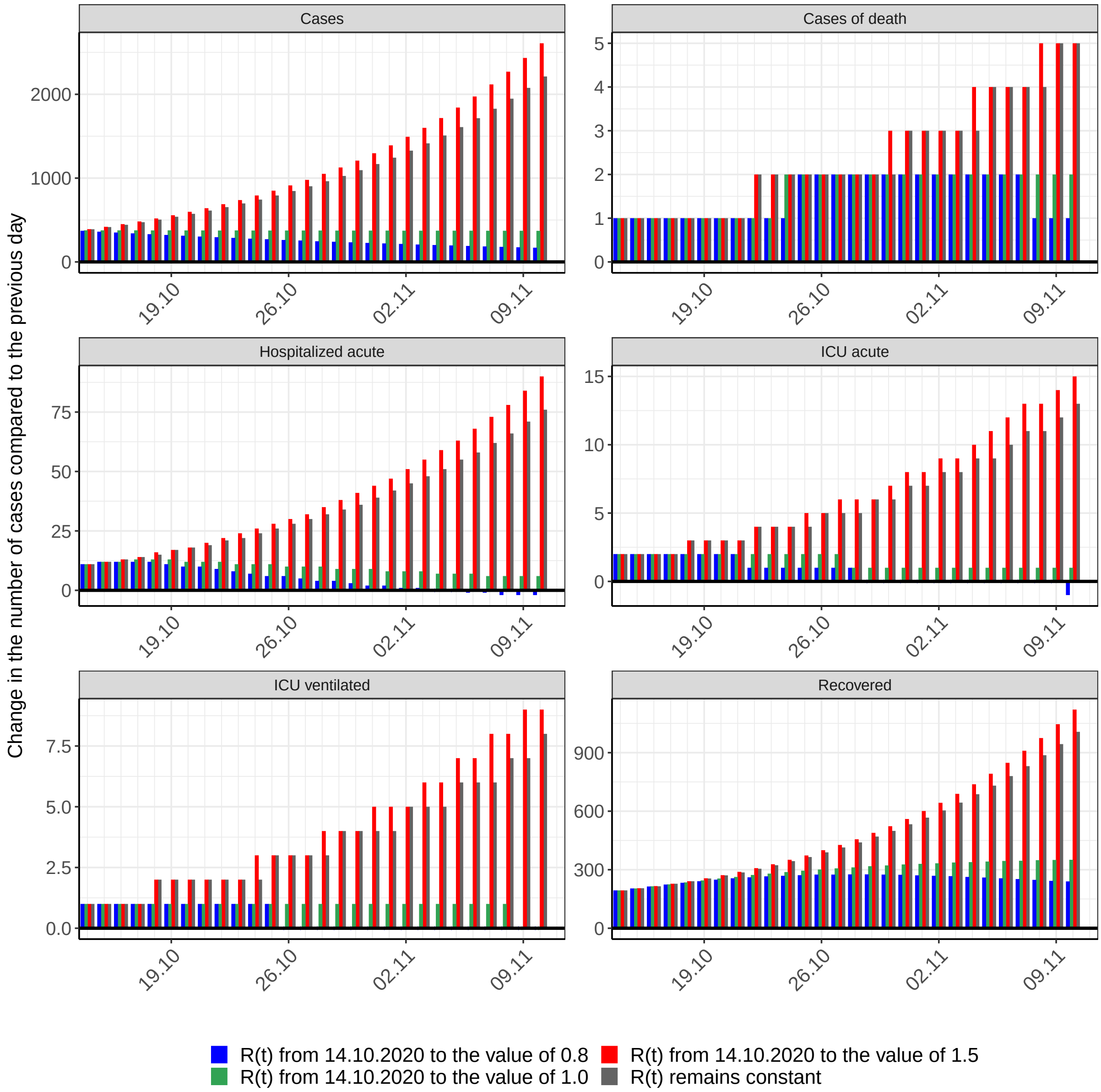



Figure 102: Simulation of daily new cases for the next 4 weeks - Lower Saxony

# 11 North Rhine-Westphalia

## 11.1 Model description

Fig. 103 depicts the results of the modeling (lines) compared to the observed data (points) for North Rhine-Westphalia on a linear (A) and semi-logarithmic (B) scale.

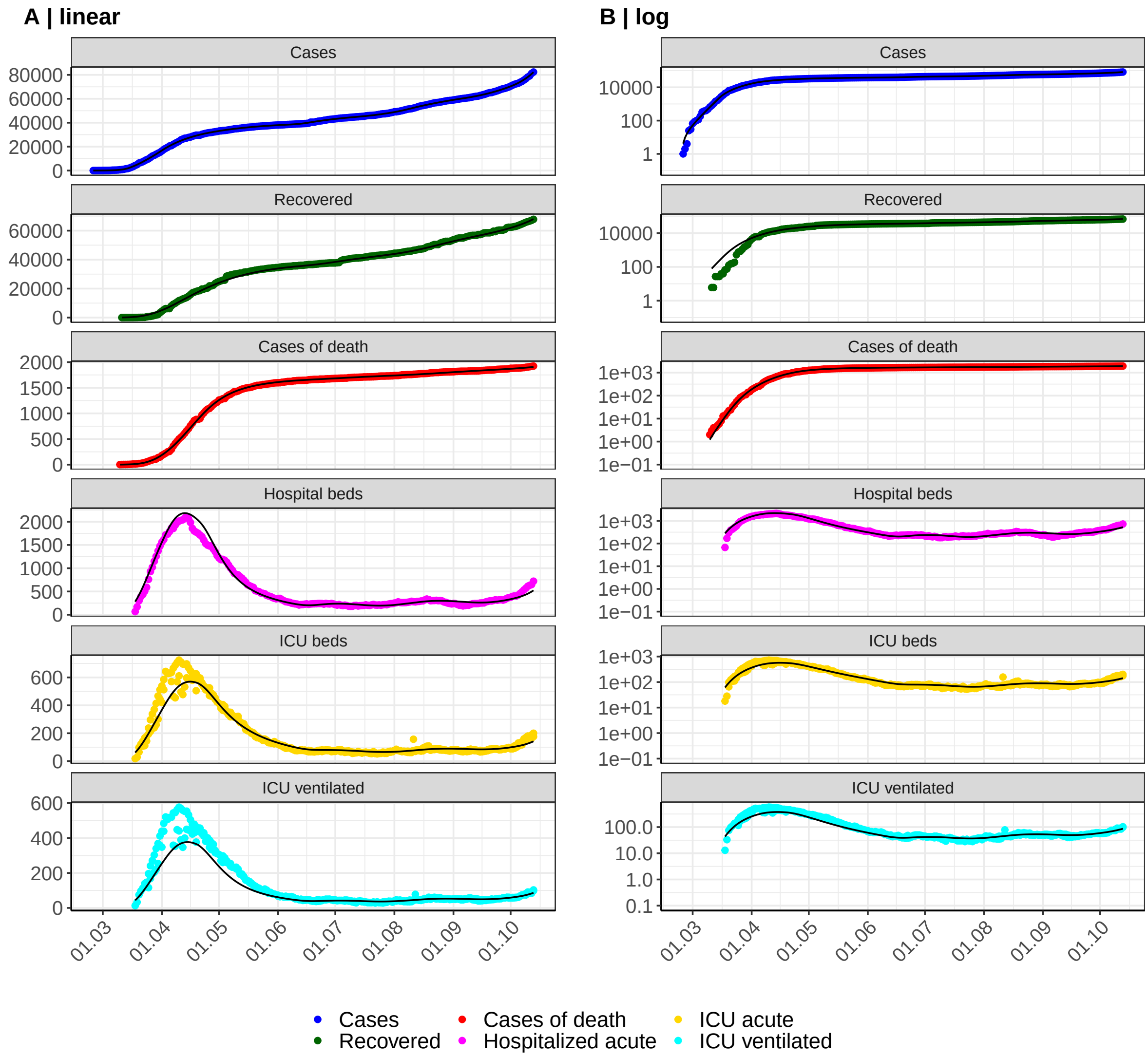



Figure 103: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in North Rhine-Westphalia. Points: reported data; lines: model description.

Fig. 104 shows the goodness-of-fit for North Rhine-Westphalia. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

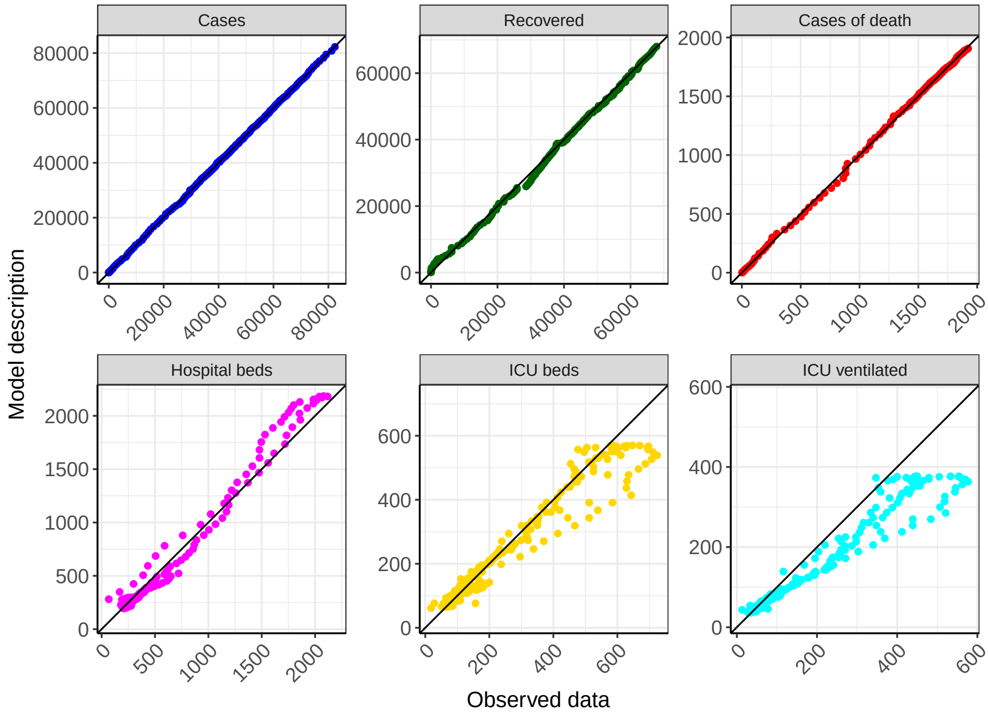



Figure 104: Goodness-of-fit plots for North Rhine-Westphalia. Lines: lines of identity.

Fig. 105 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for North Rhine-Westphalia (red line) in comparison with the other federal states (grey lines).

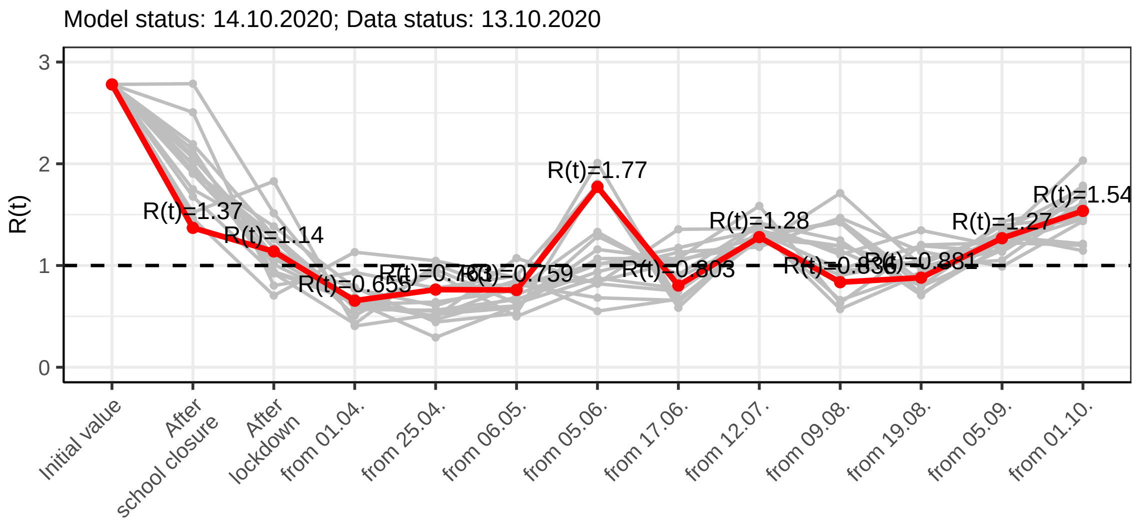



Figure 105: R(t) values before and after the NPIs for North Rhine-Westphalia

Fig. 106 shows the R(t) estimated value for North Rhine-Westphalia (red line) over time in comparison with the other federal states (grey lines).

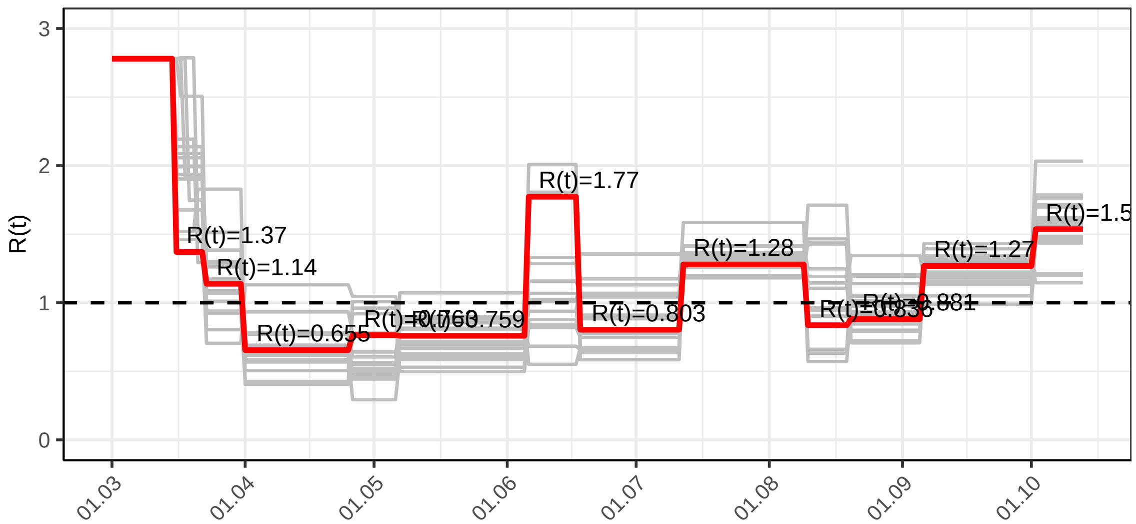



Figure 106: R(t) values over time for North Rhine-Westphalia

Fig. 107 shows the changes in hospitalization and death rates for North Rhine-Westphalia (red line) over time compared to the other states (grey lines).

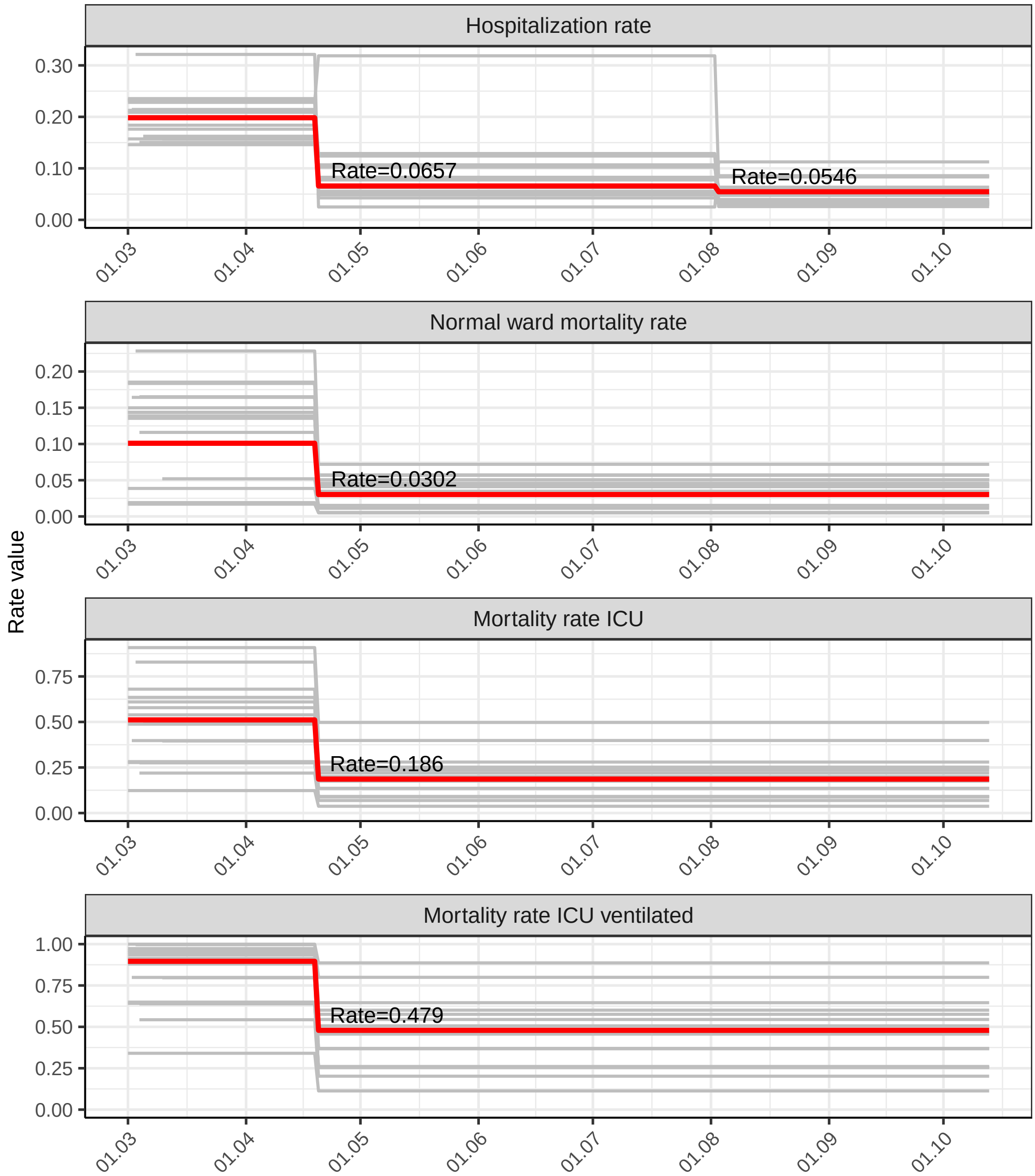



Figure 107: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for North Rhine-Westphalia

## 11.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.54)

Fig.108 and 109 depict the the model predictions for the next 4 weeks for North Rhine-Westphalia on a linear (108) and a semi-logarithmic (109) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

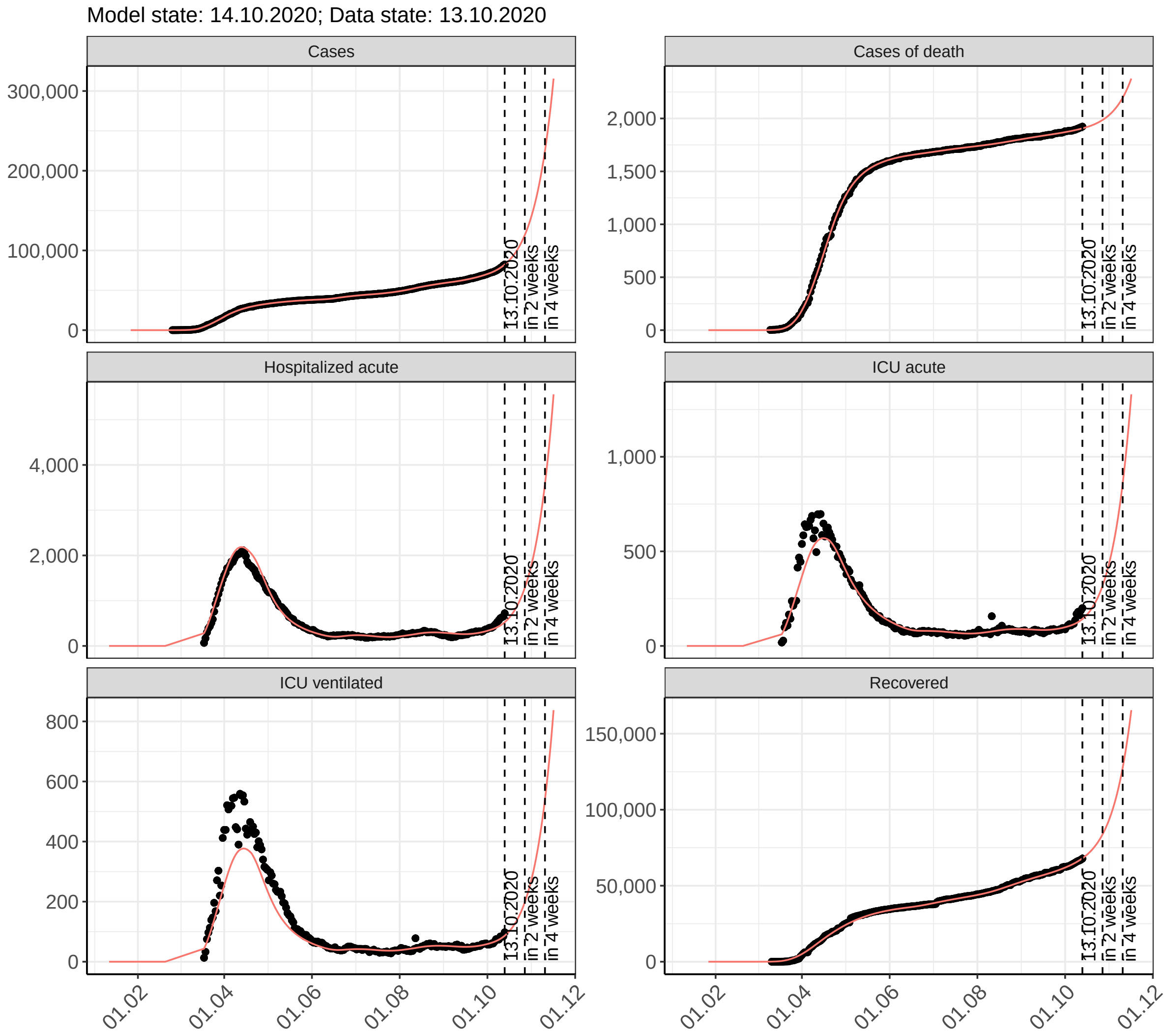



Figure 108: Representation of the model predictions for North Rhine-Westphalia for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

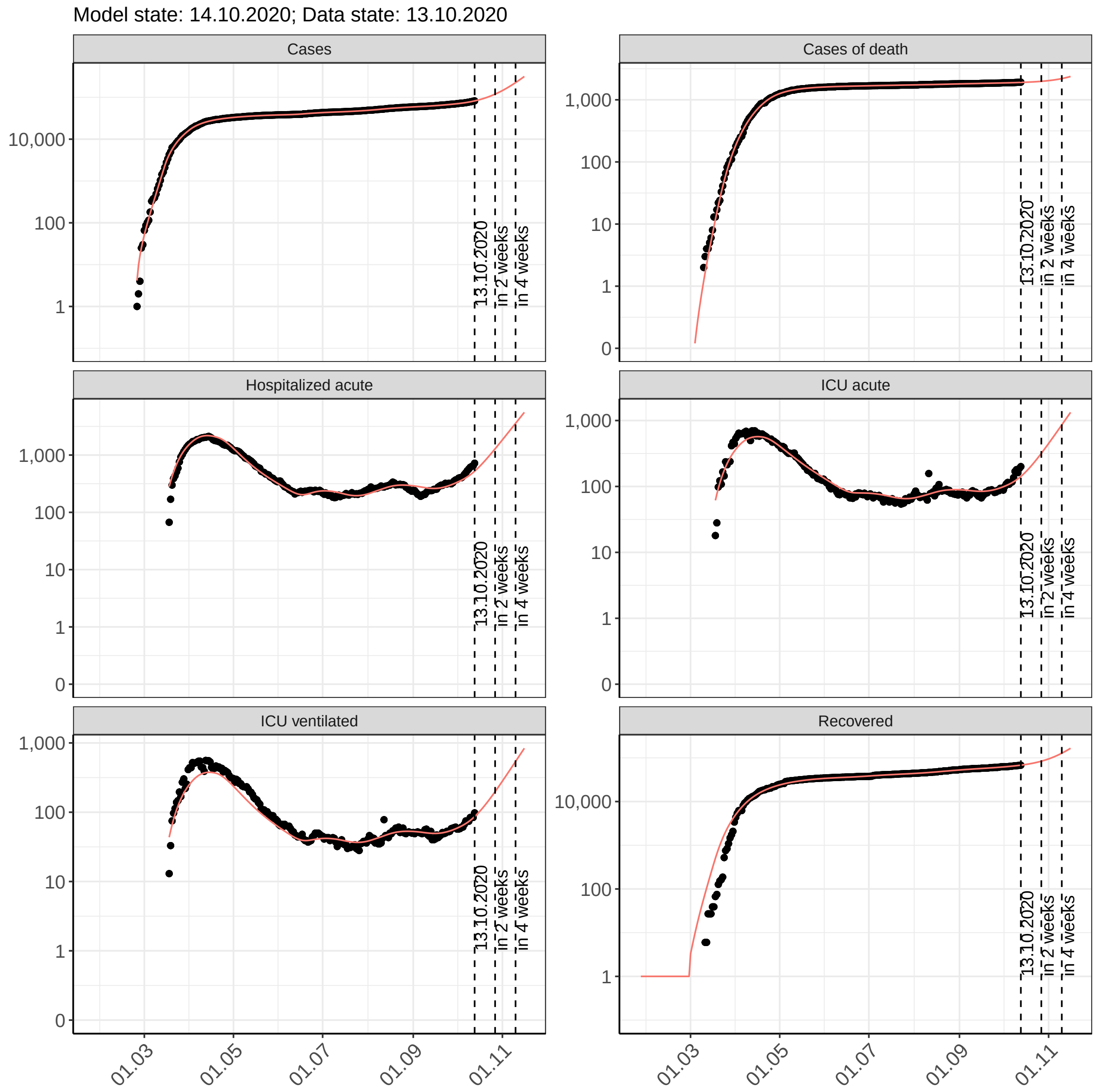



Figure 109: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for North Rhine-Westphalia for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.110 and 111 represent the model prediction for the next 8 weeks for North Rhine-Westphalia on a linear (110) and a semi-logarithmic (111) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

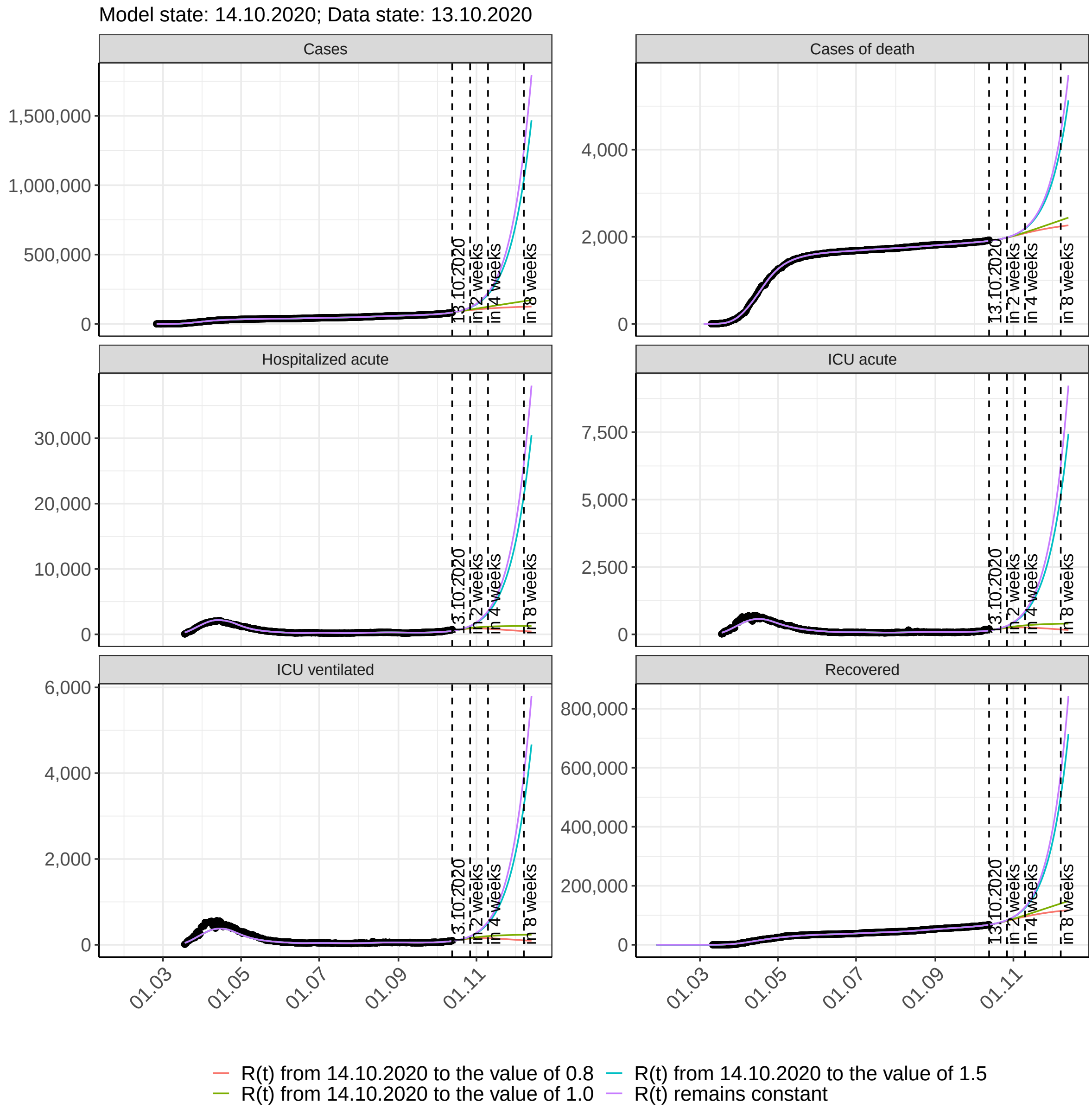



Figure 110: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for North Rhine-Westphalia assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

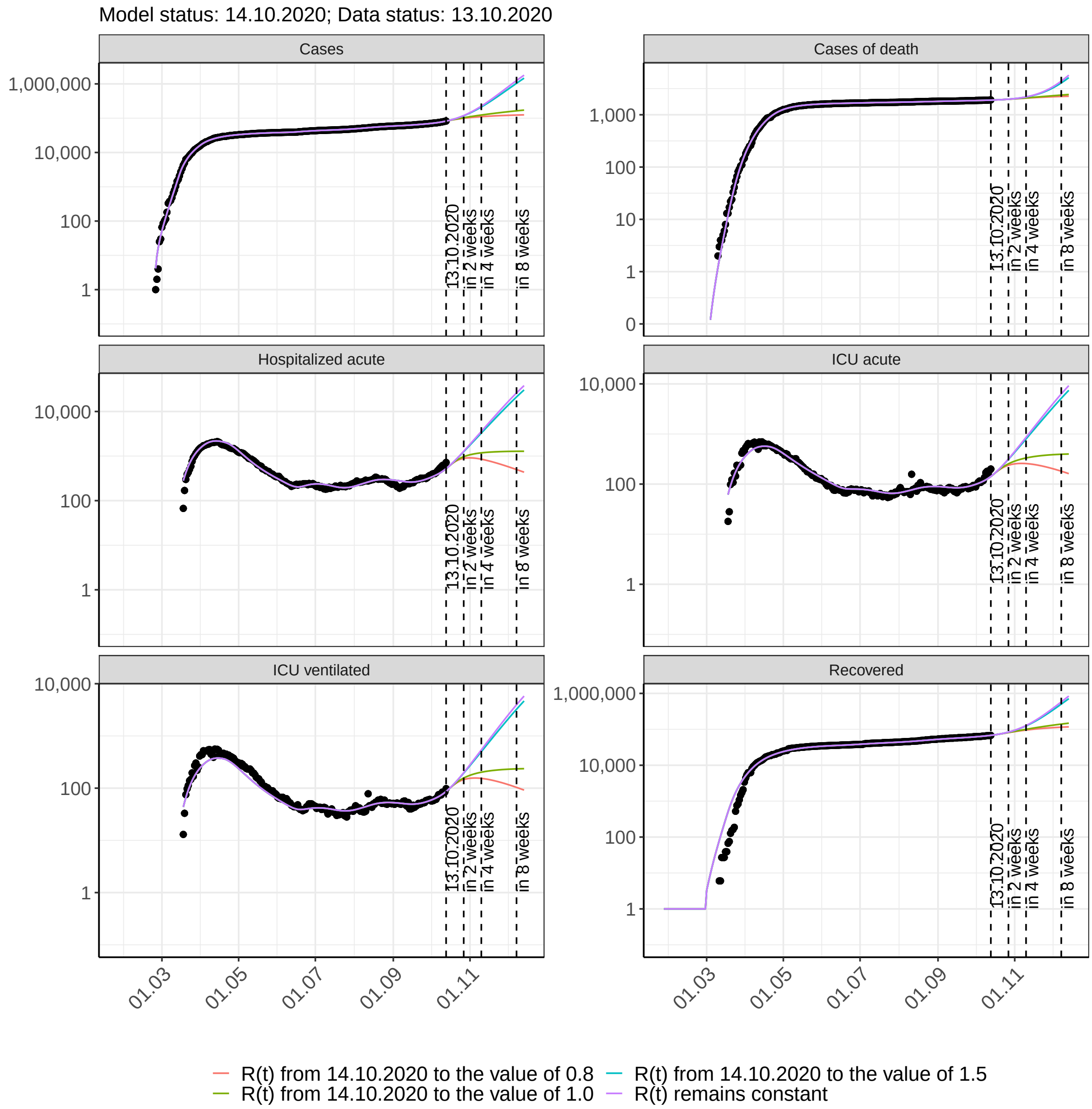



Figure 111: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for North Rhine-Westphalia assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

**Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020**

Fig. 112 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

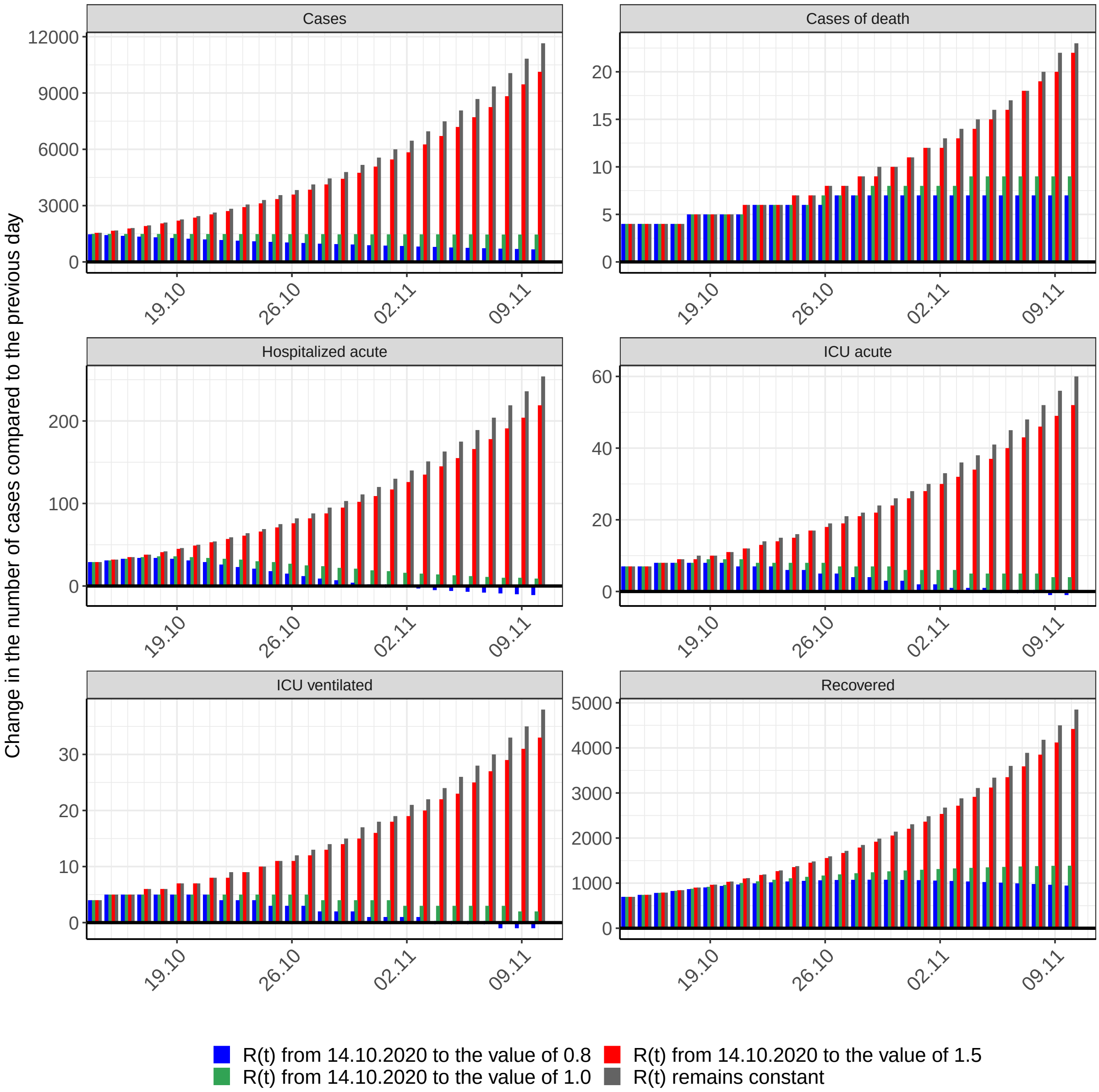



Figure 112: Simulation of daily new cases for the next 4 weeks - North Rhine-Westphalia

# 12 Rhineland-Palatinate

## 12.1 Model description

Fig. 113 depicts the results of the modeling (lines) compared to the observed data (points) for Rhineland-Palatinate on a linear (A) and semi-logarithmic (B) scale.

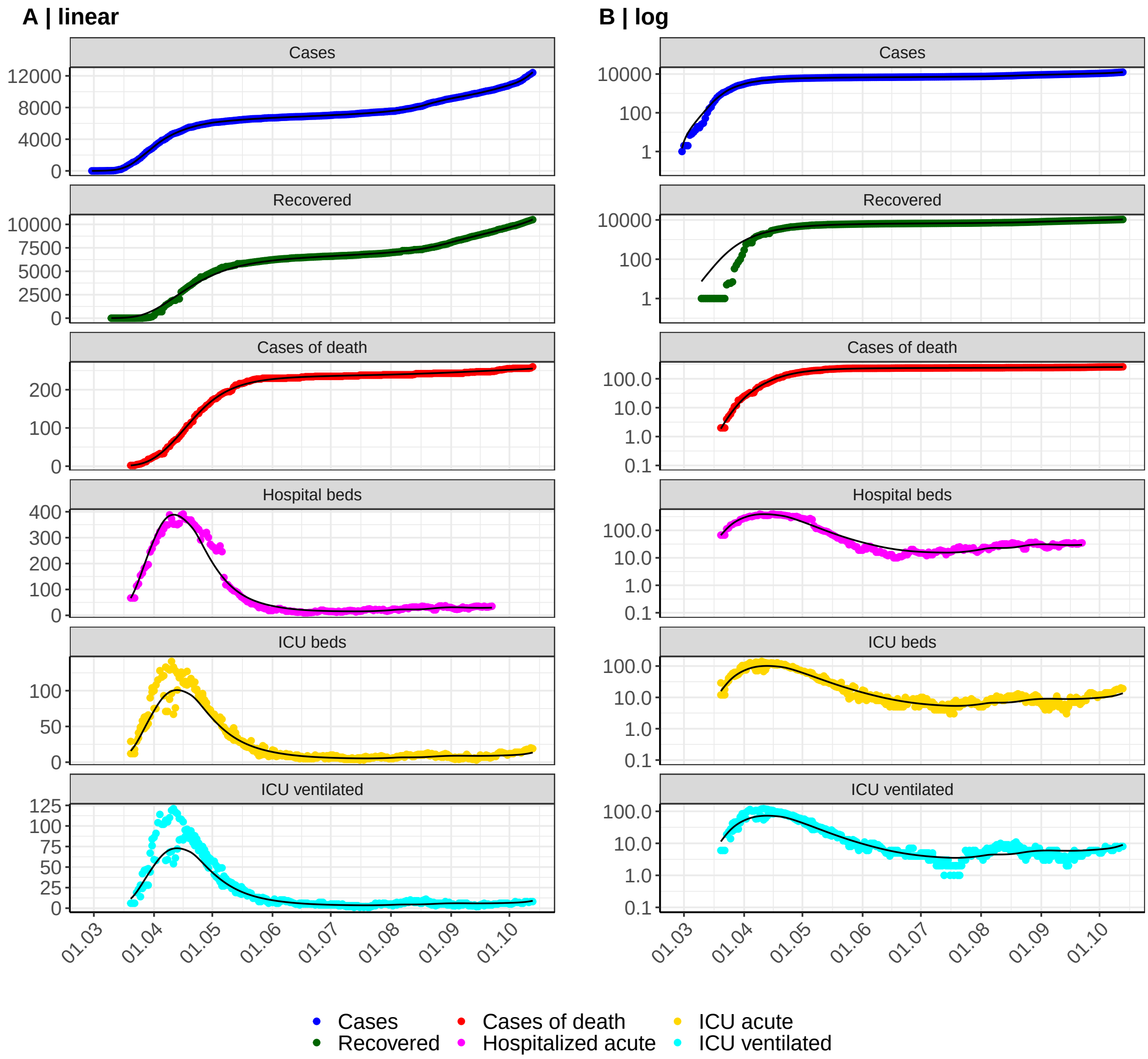



Figure 113: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Rhineland-Palatinate. Points: reported data; lines: model description.

Fig. 114 shows the goodness-of-fit for Rhineland-Palatinate. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

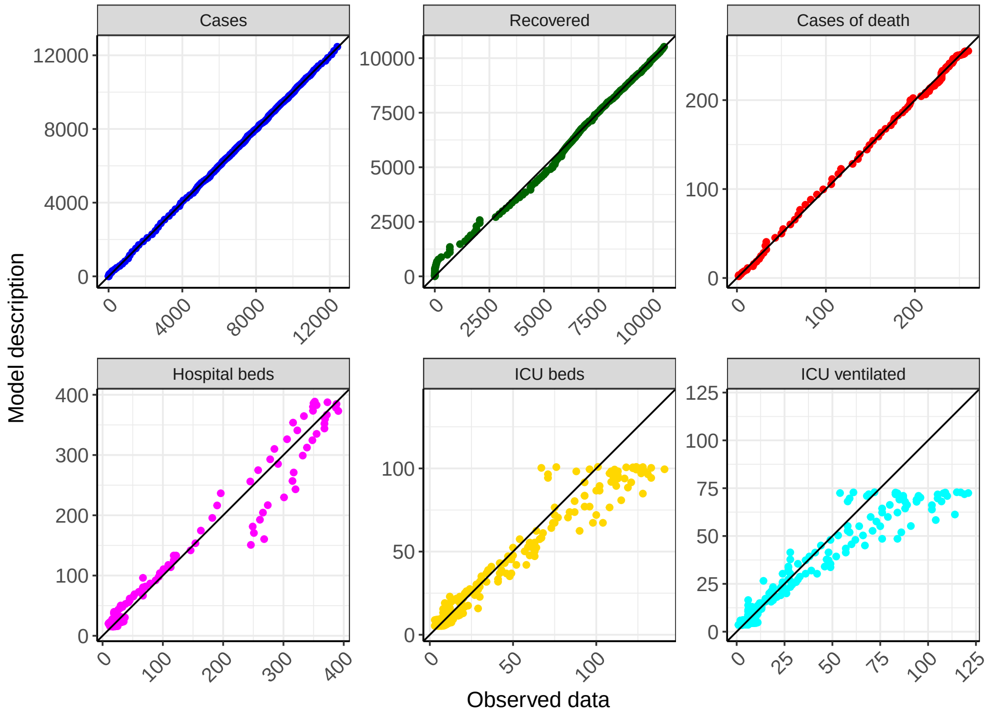



Figure 114: Goodness-of-fit plots for Rhineland-Palatinate. Lines: lines of identity.

Fig. 115 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Rhineland-Palatinate (red line) in comparison with the other federal states (grey lines).

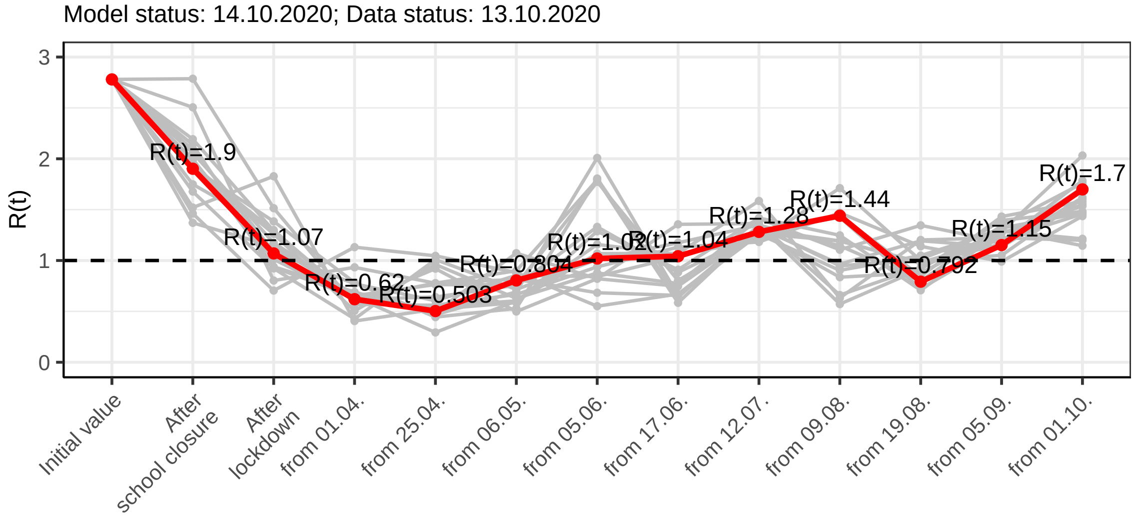



Figure 115: R(t) values before and after the NPIs for Rhineland-Palatinate

Fig. 116 shows the R(t) estimated value for Rhineland-Palatinate (red line) over time in comparison with the other federal states (grey lines).

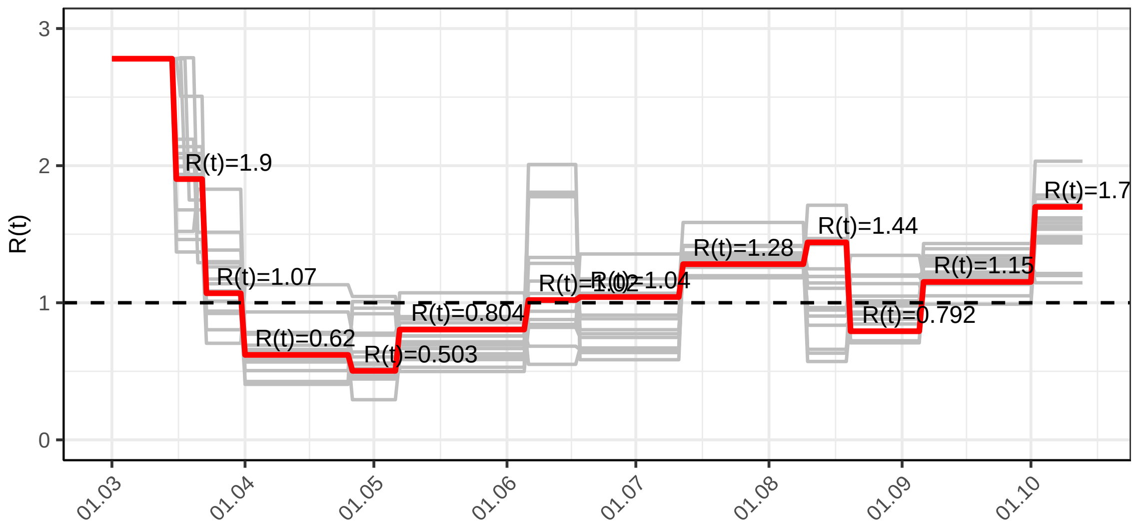



Figure 116: R(t) values over time for Rhineland-Palatinate

Fig. 117 shows the changes in hospitalization and death rates for Rhineland-Palatinate (red line) over time compared to the other states (grey lines).

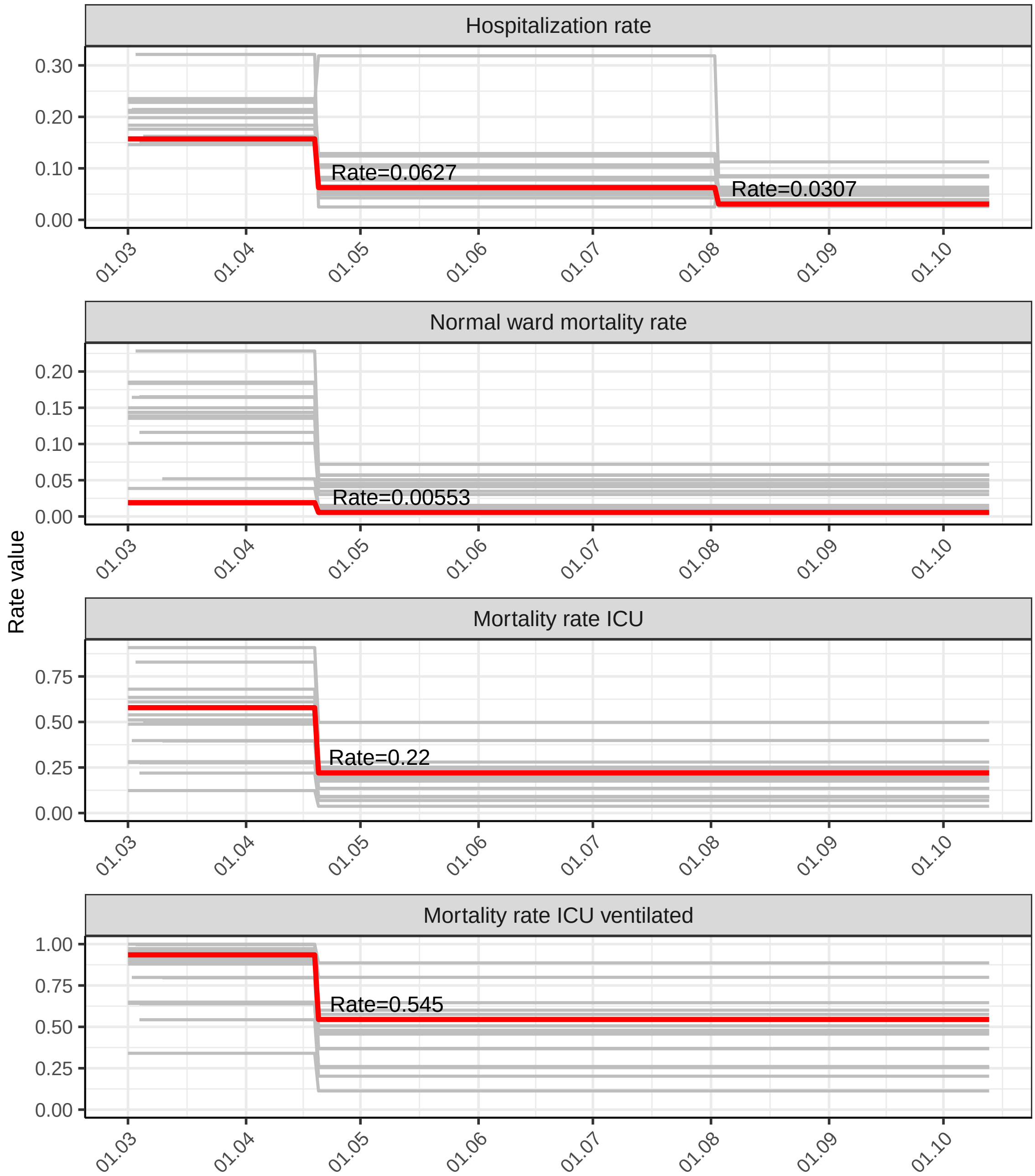



Figure 117: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Rhineland-Palatinate

## 12.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.7)

Fig.118 and 119 depict the the model predictions for the next 4 weeks for Rhineland-Palatinate on a linear (118) and a semi-logarithmic (119) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

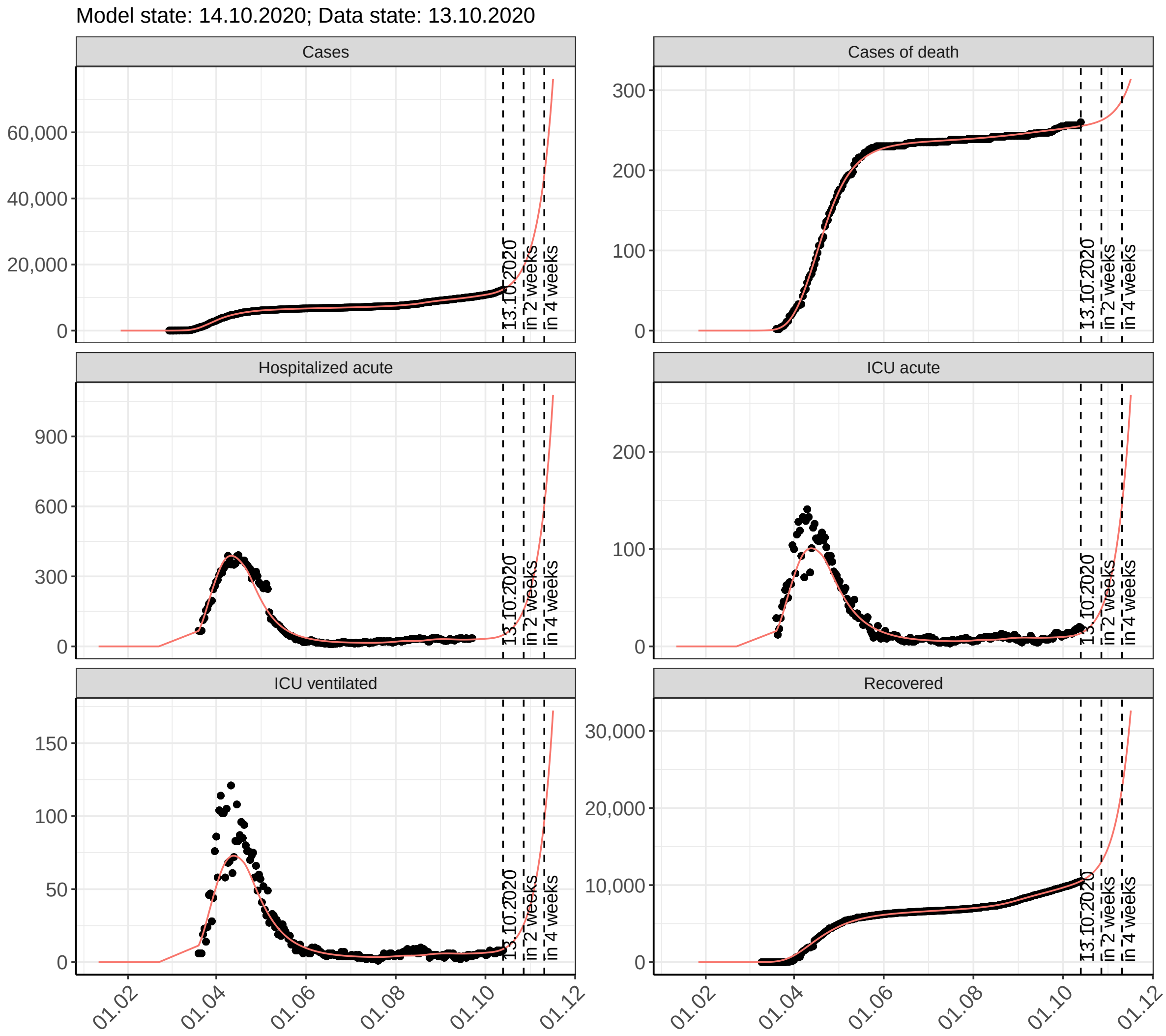



Figure 118: Representation of the model predictions for Rhineland-Palatinate for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

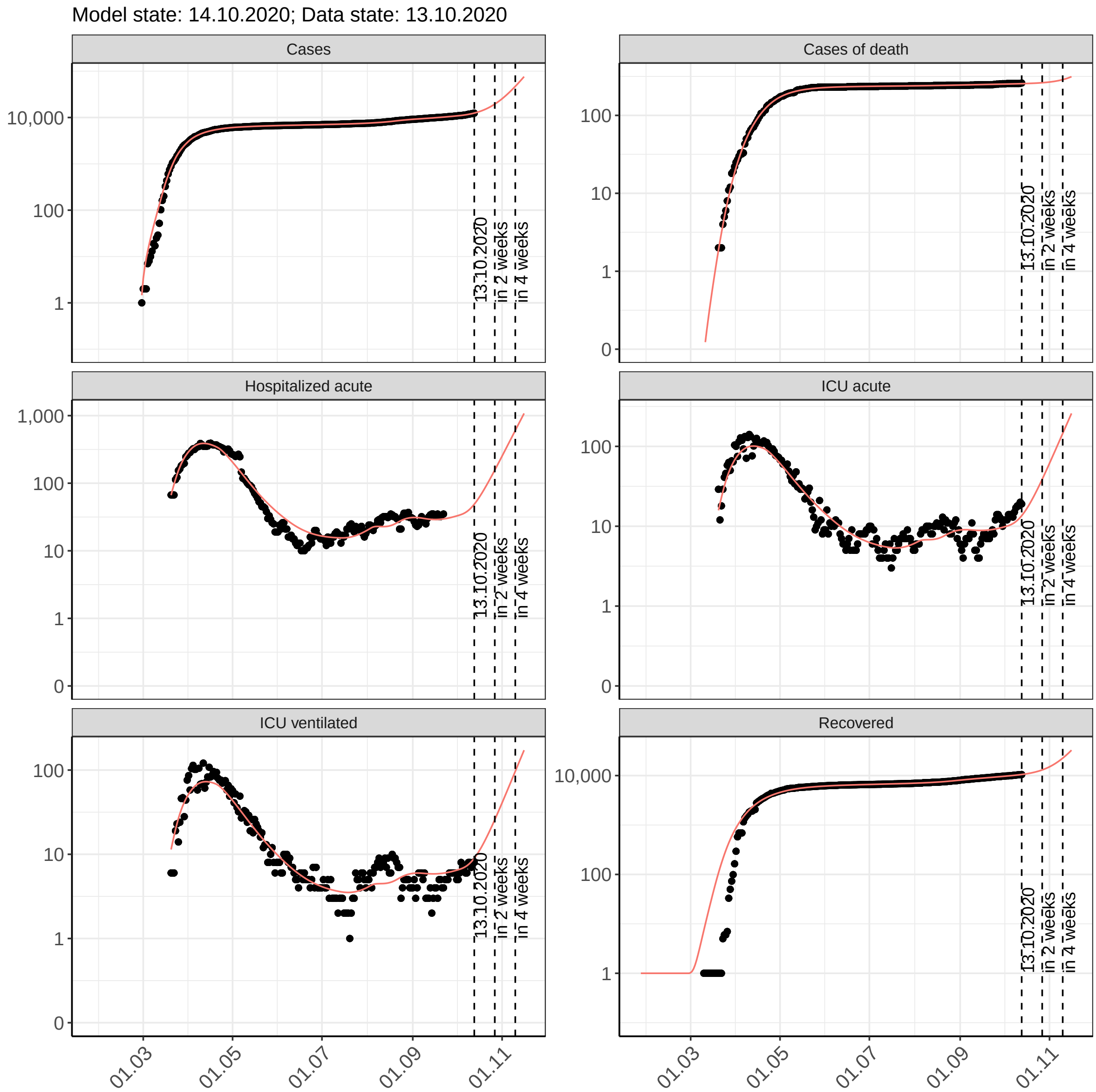



Figure 119: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Rhineland-Palatinate for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.120 and 121 represent the model prediction for the next 8 weeks for Rhineland-Palatinate on a linear (120) and a semi-logarithmic (121) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

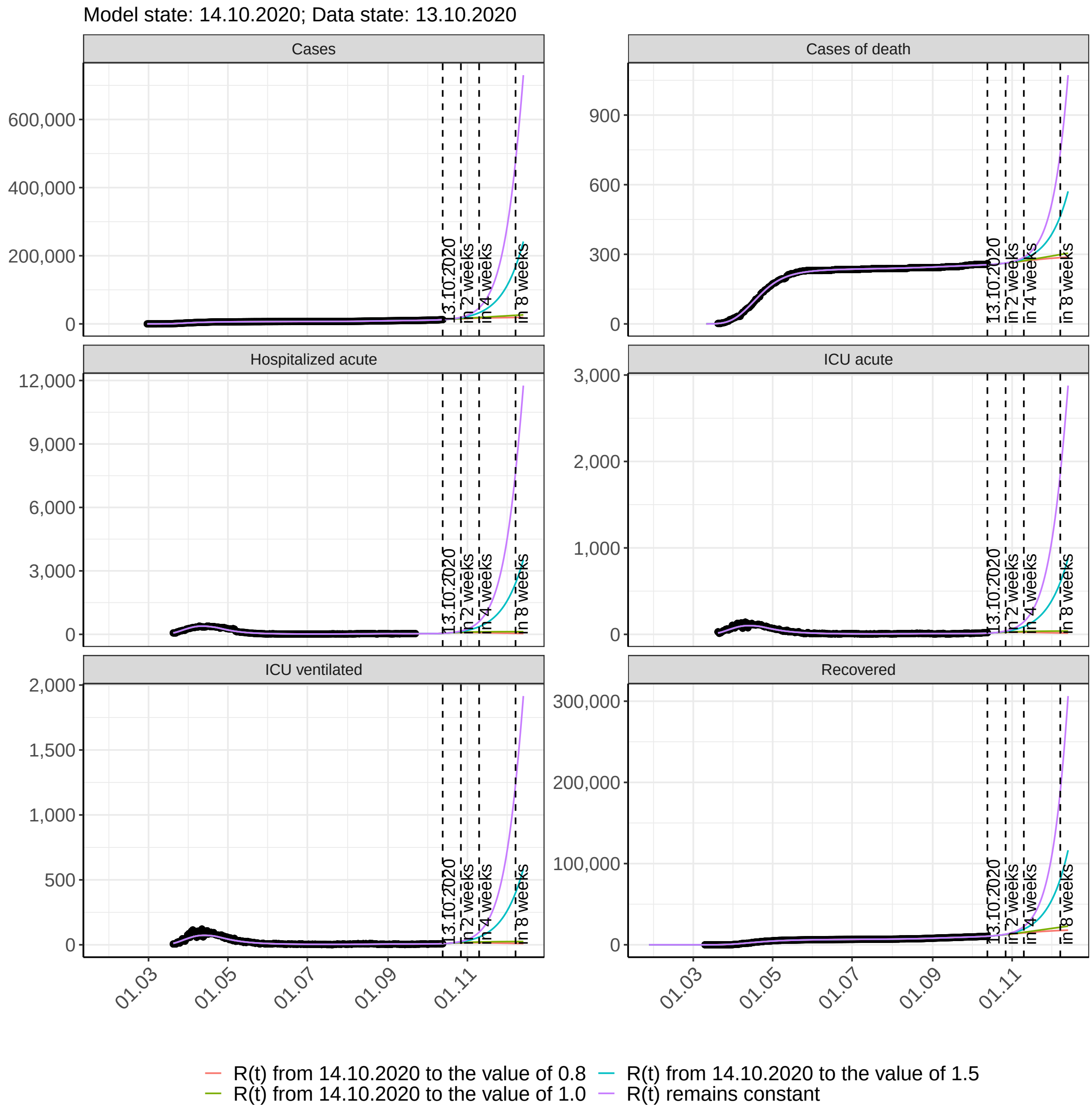



Figure 120: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Rhineland-Palatinate assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

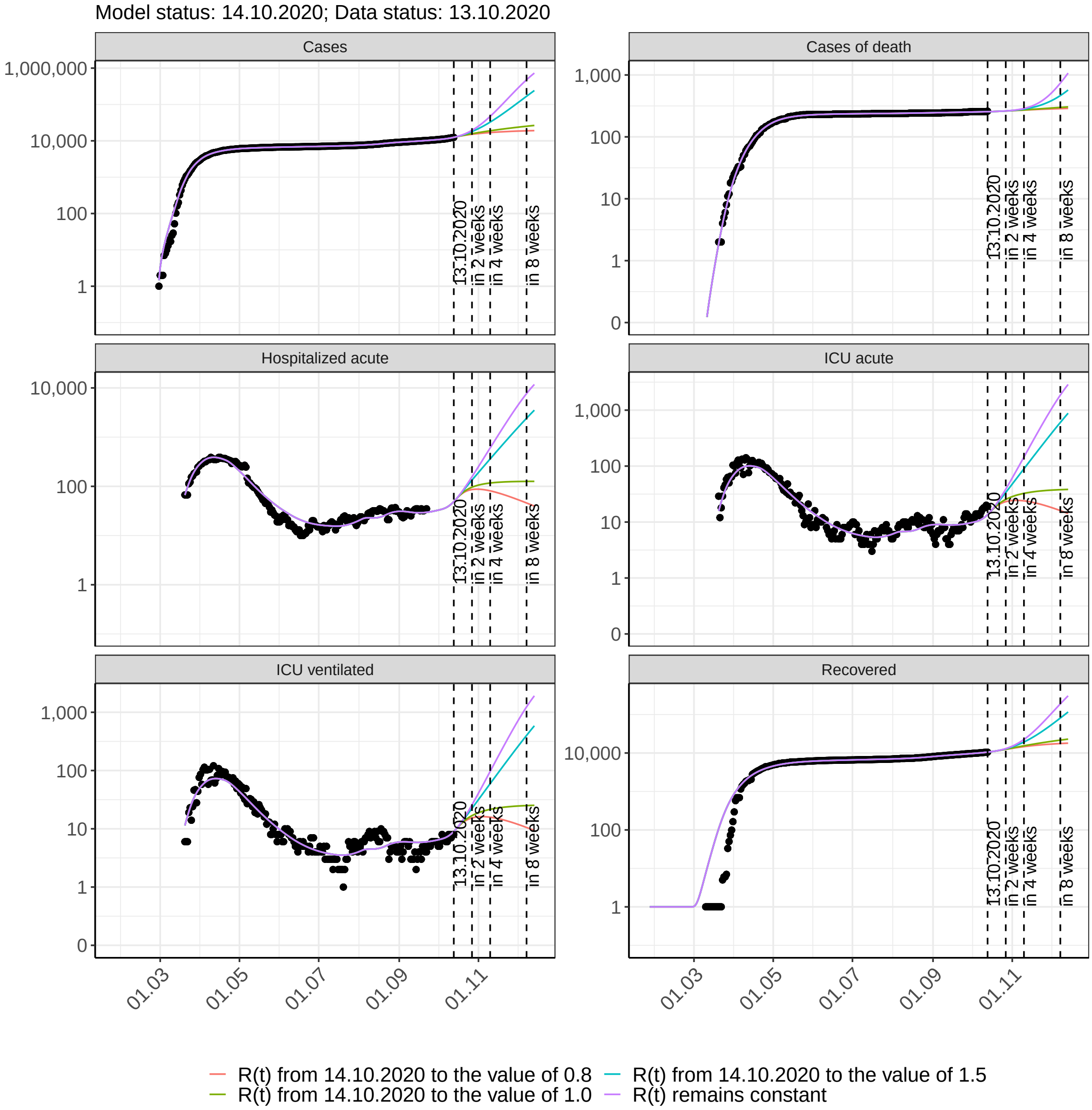



Figure 121: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Rhineland-Palatinate assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 122 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

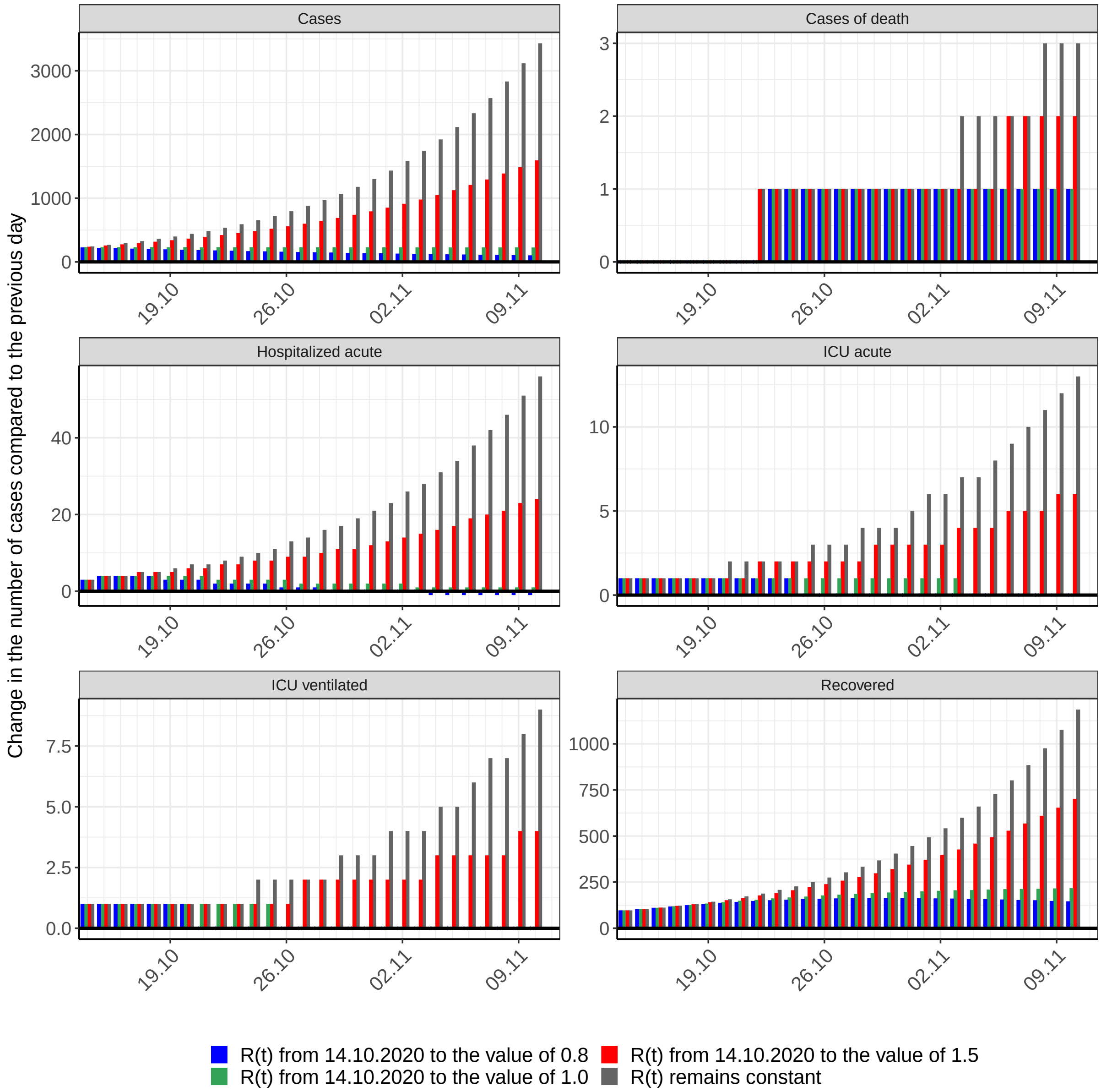



Figure 122: Simulation of daily new cases for the next 4 weeks - Rhineland-Palatinate

# 13 Saarland

## 13.1 Model description

Fig. 123 depicts the results of the modeling (lines) compared to the observed data (points) for Saarland on a linear (A) and semi-logarithmic (B) scale.

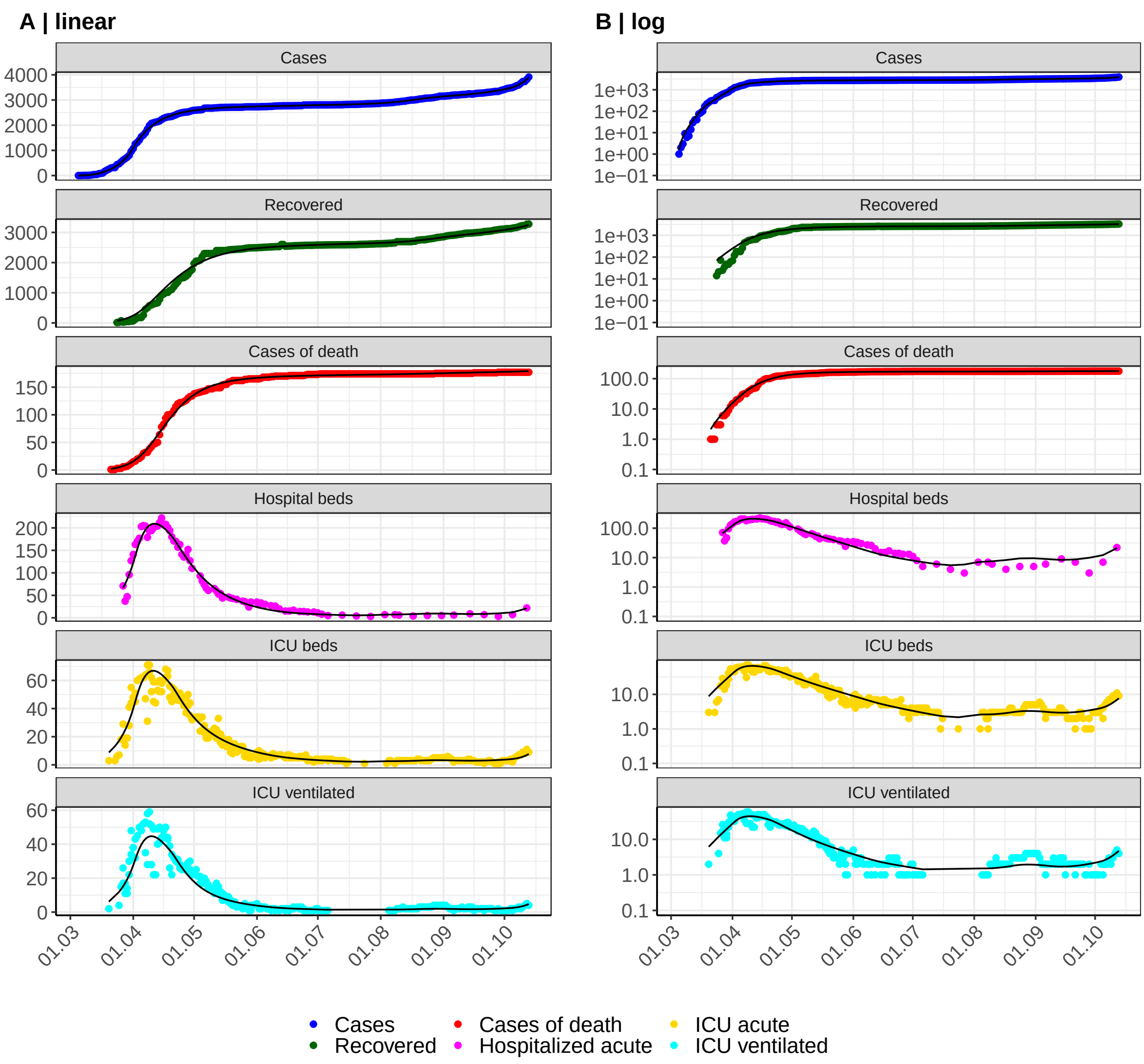



Figure 123: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Saarland. Points: reported data; lines: model description.

Fig. 124 shows the goodness-of-fit for Saarland. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

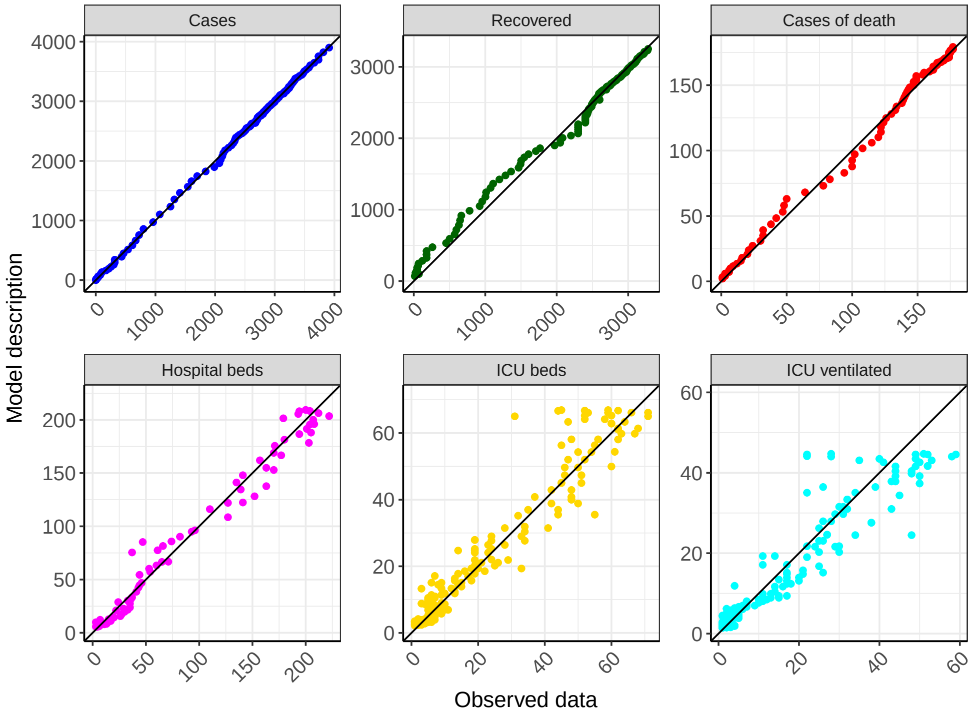



Figure 124: Goodness-of-fit plots for Saarland. Lines: lines of identity.

Fig. 125 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Saarland (red line) in comparison with the other federal states (grey lines).

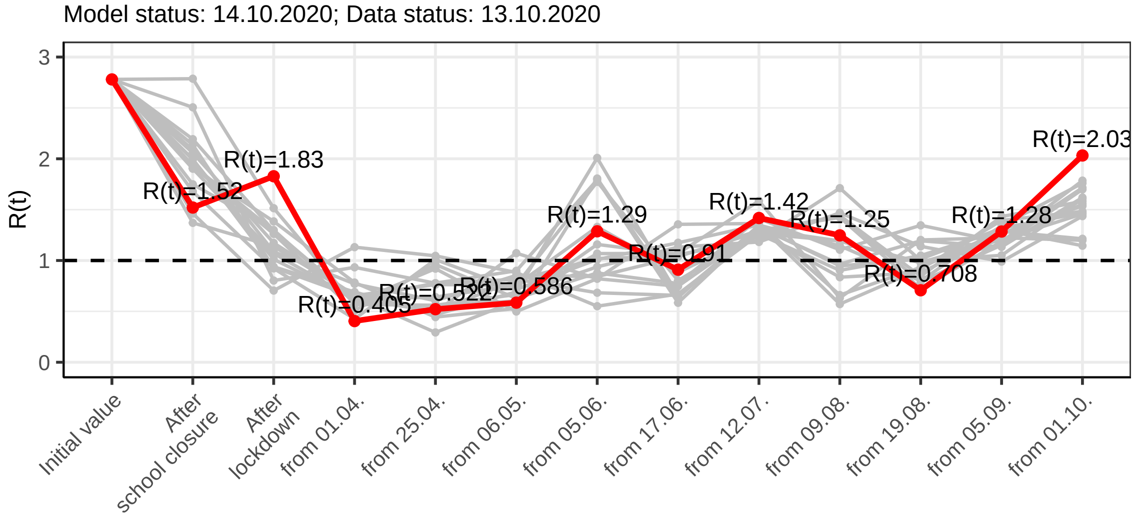



Figure 125: R(t) values before and after the NPIs for Saarland

Fig. 126 shows the R(t) estimated value for Saarland (red line) over time in comparison with the other federal states (grey lines).

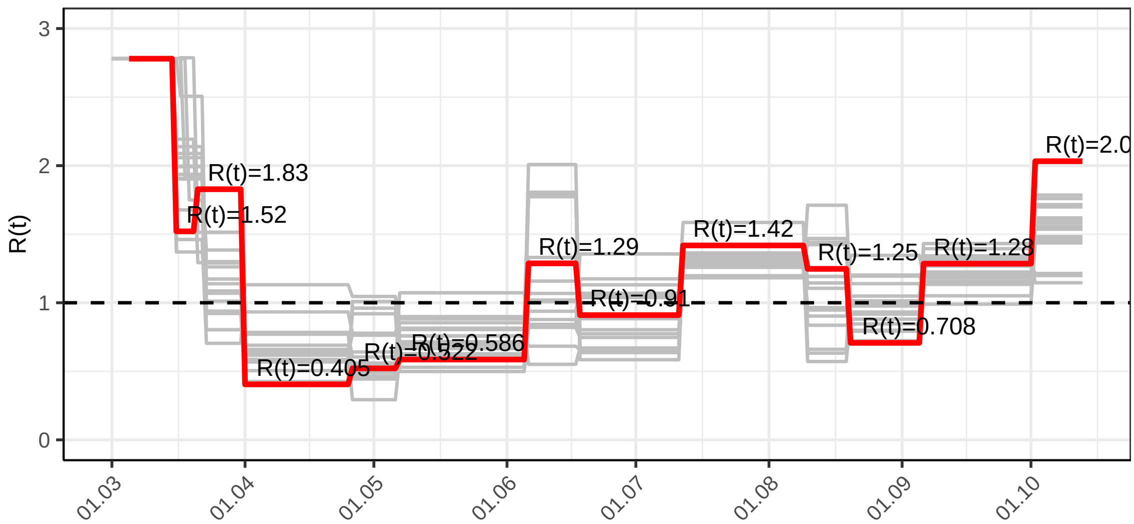



Figure 126: R(t) values over time for Saarland

Fig. 127 shows the changes in hospitalization and death rates for Saarland (red line) over time compared to the other states (grey lines).

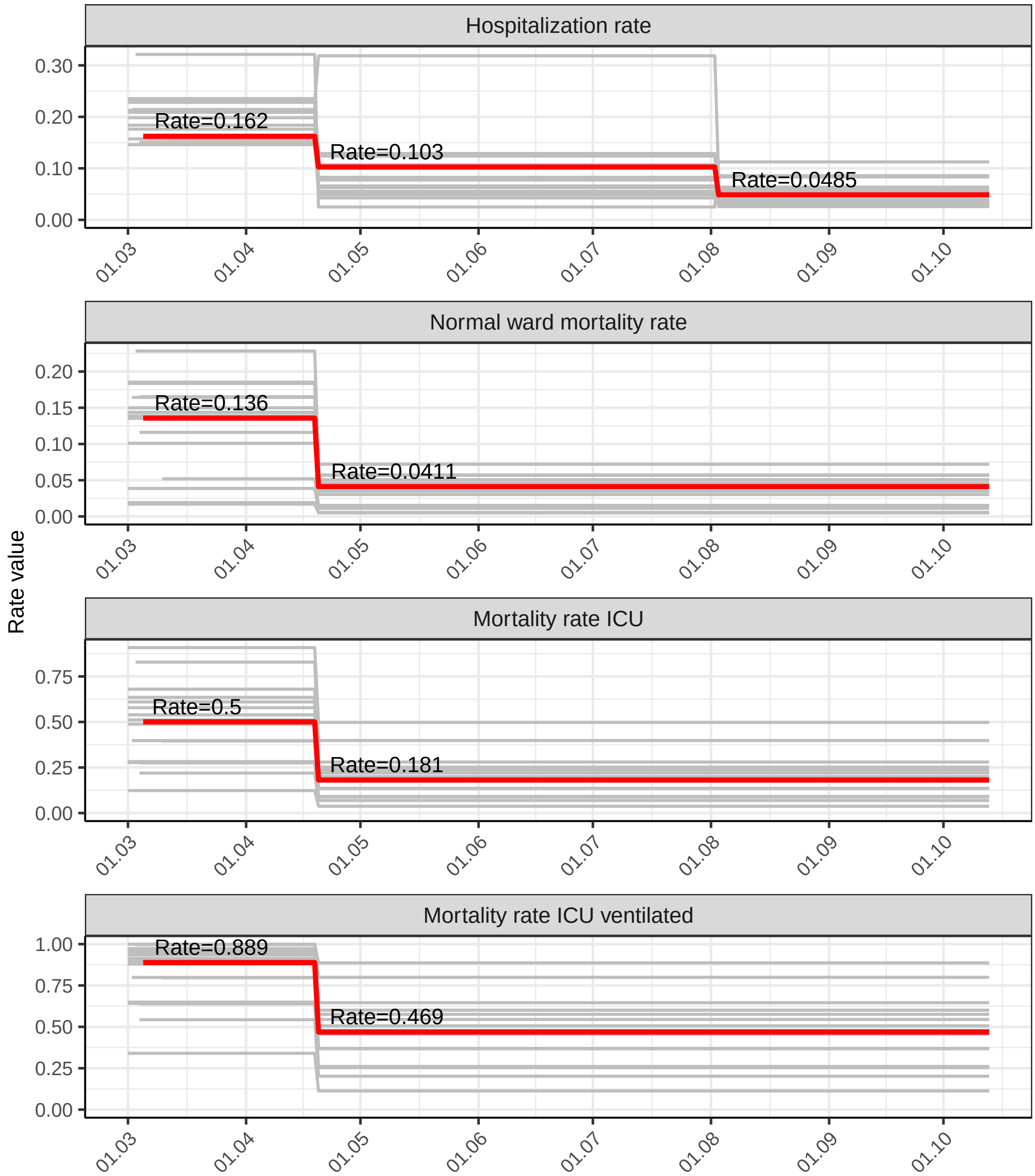



Figure 127: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Saarland

## 13.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 2.03)

Fig.128 and 129 depict the the model predictions for the next 4 weeks for Saarland on a linear (128) and a semi-logarithmic (129) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

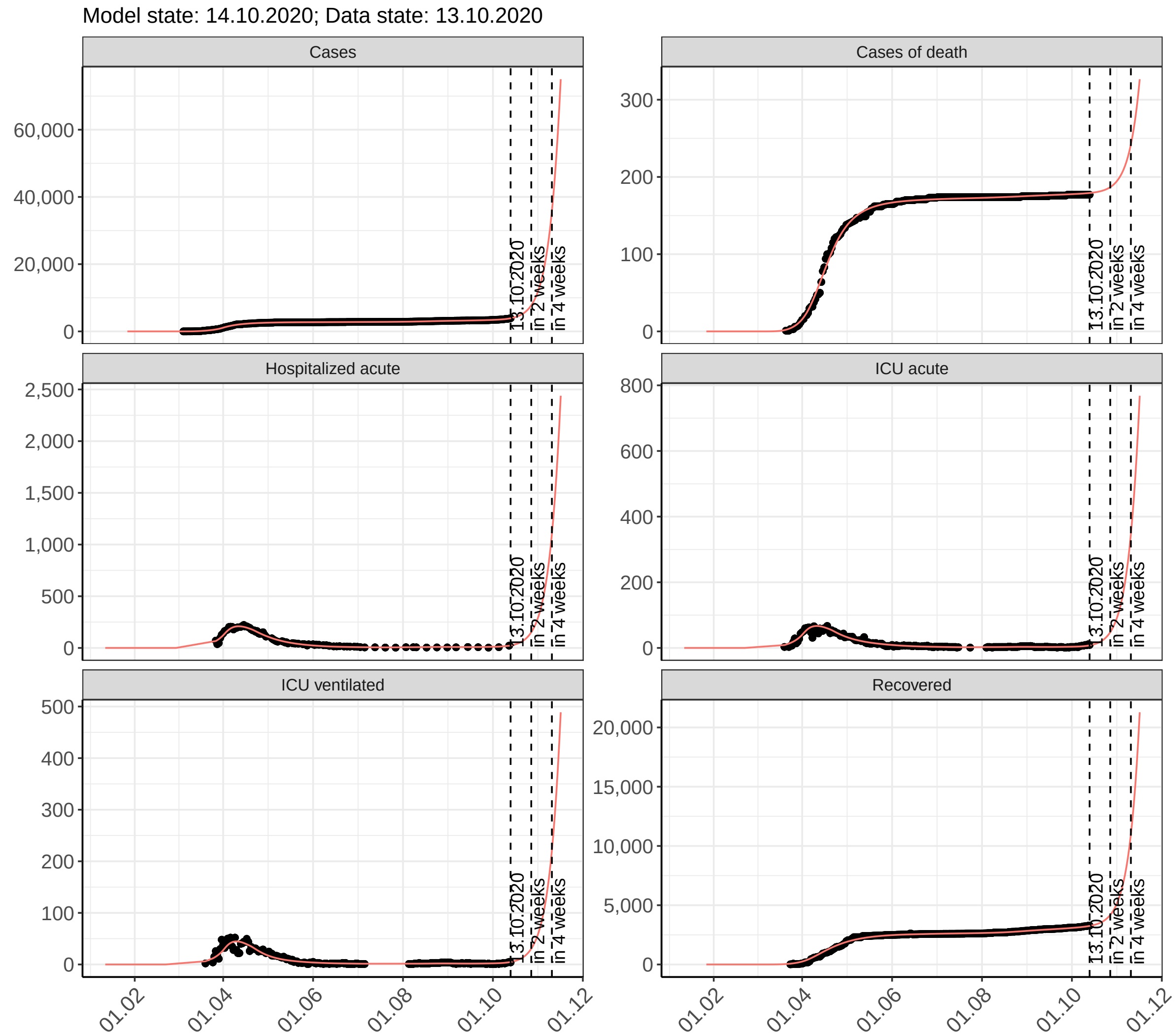



Figure 128: Representation of the model predictions for Saarland for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

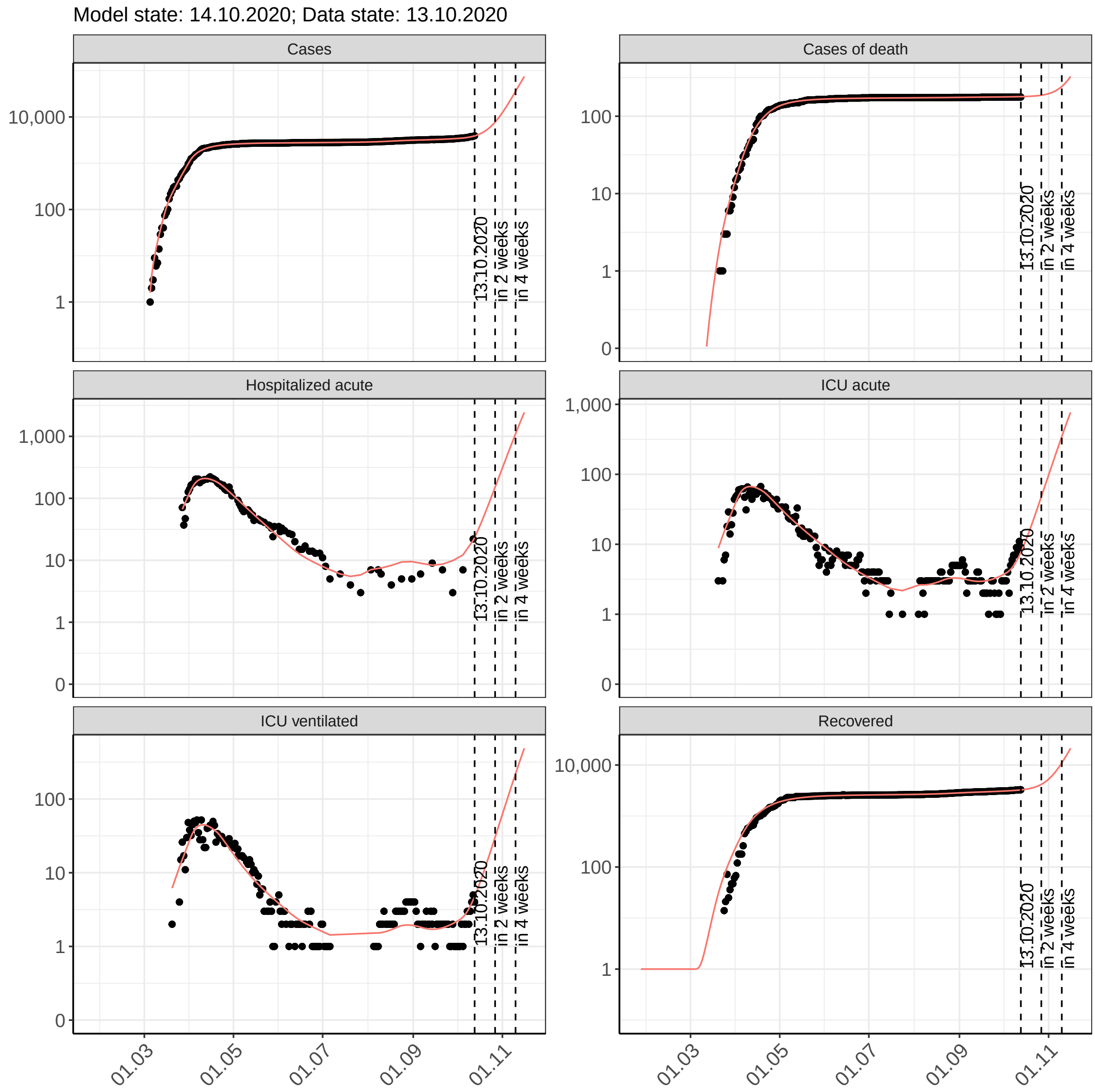



Figure 129: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saarland for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.130 and 131 represent the model prediction for the next 8 weeks for Saarland on a linear (130) and a semi-logarithmic (131) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

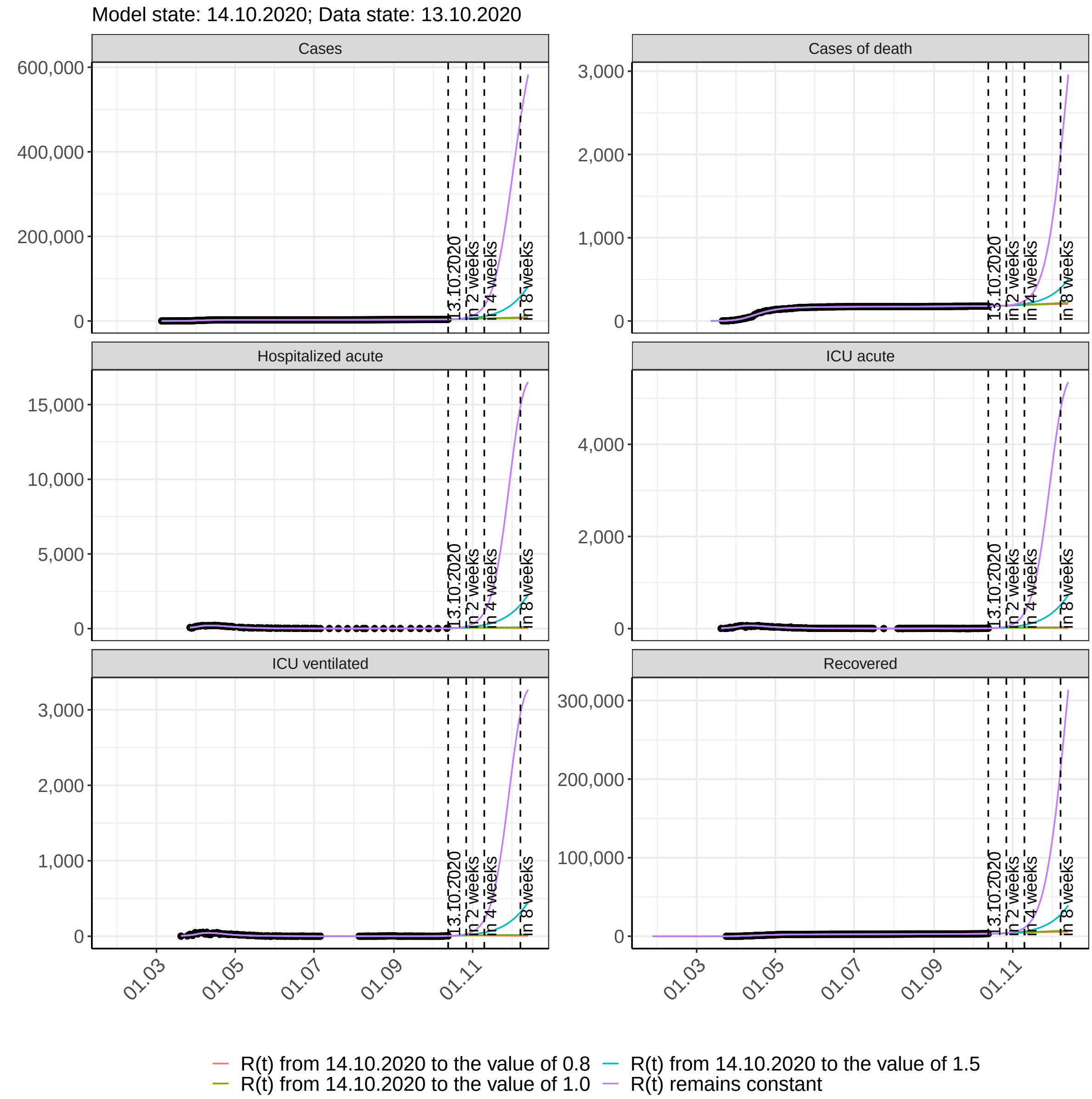



Figure 130: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saarland assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

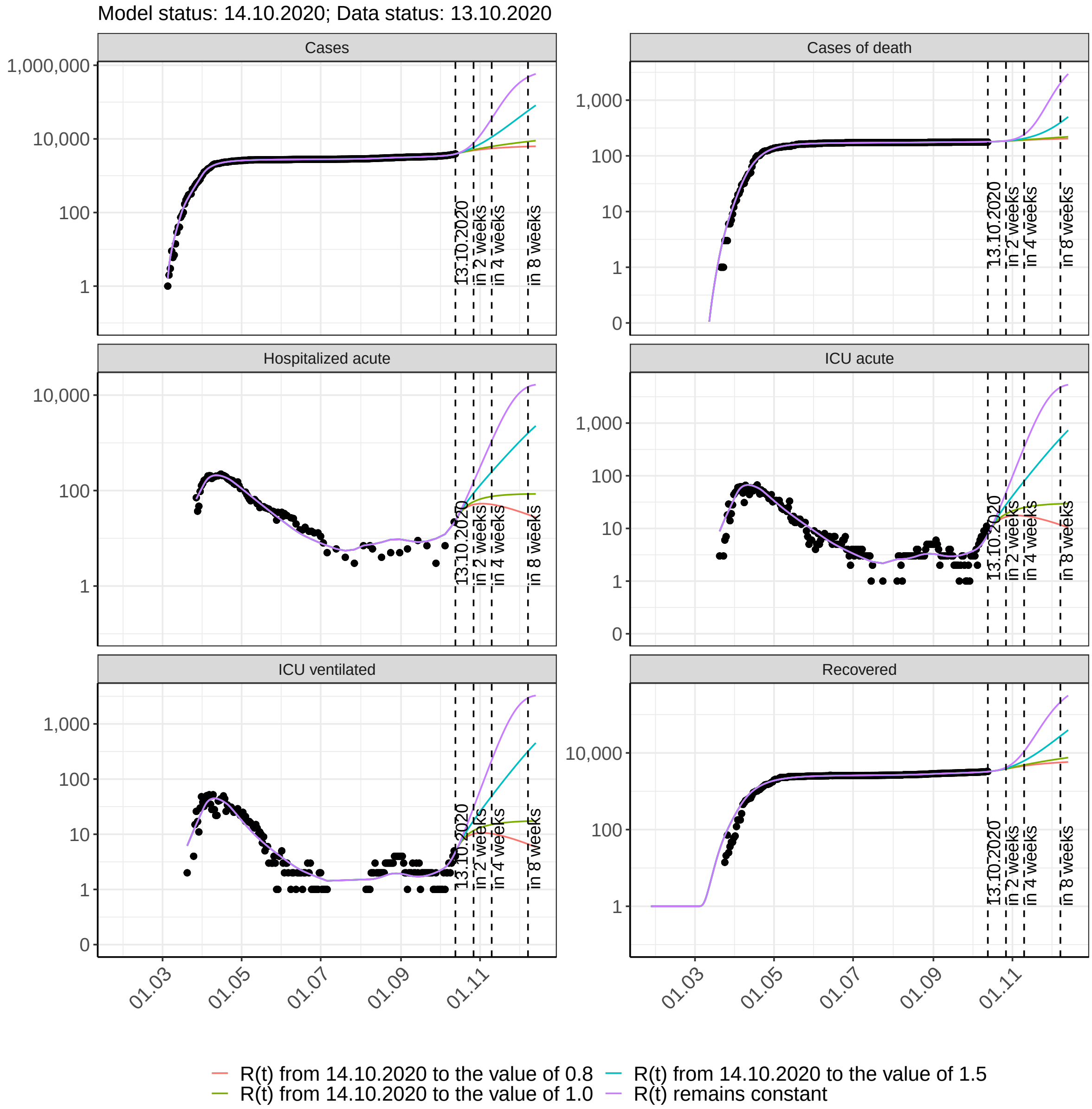



Figure 131: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saarland assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

**Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020**

Fig. 132 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

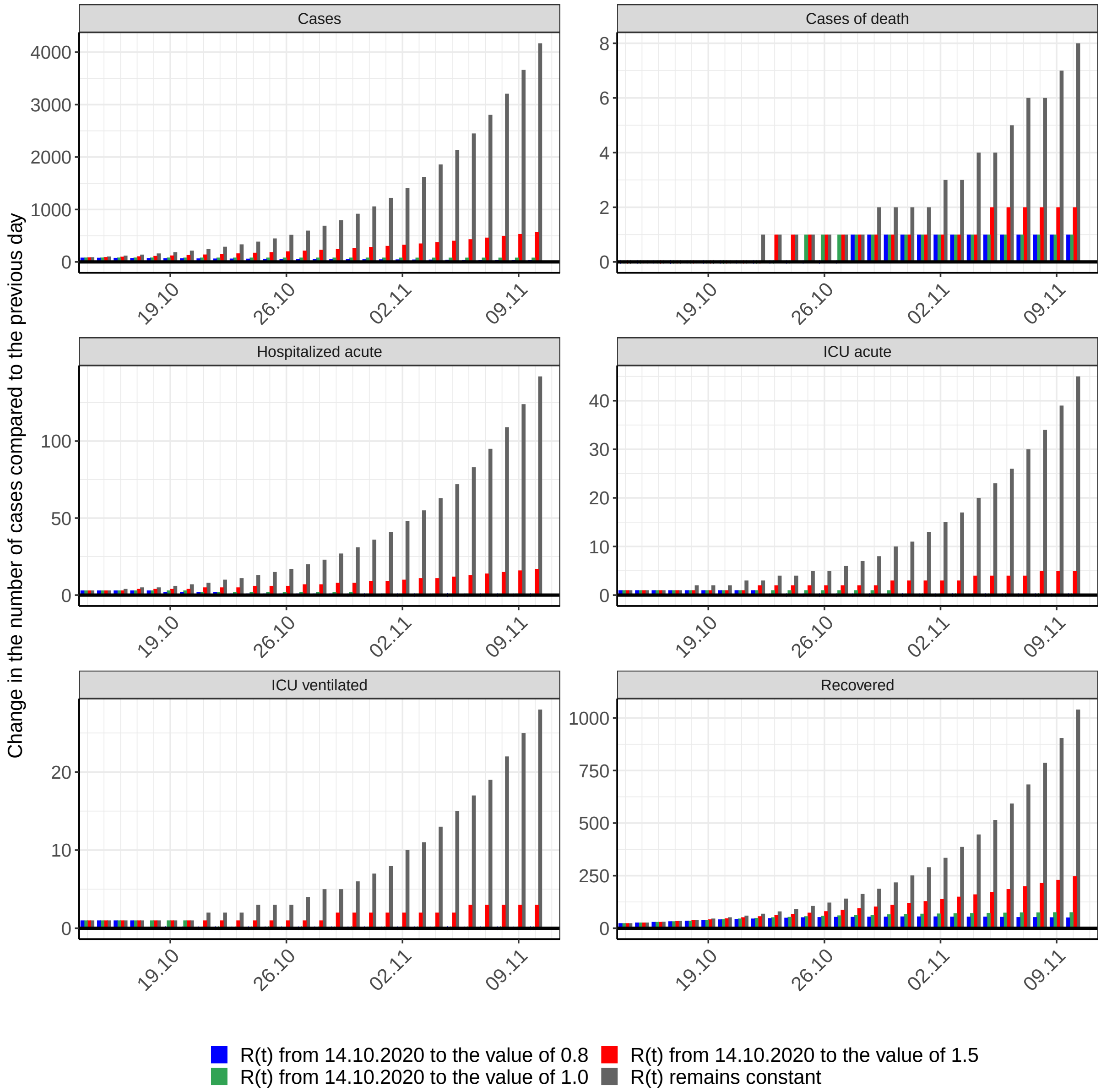



Figure 132: Simulation of daily new cases for the next 4 weeks - Saarland

# 14 Saxony

## 14.1 Model description

Fig. 133 depicts the results of the modeling (lines) compared to the observed data (points) for Saxony on a linear (A) and semi-logarithmic (B) scale.

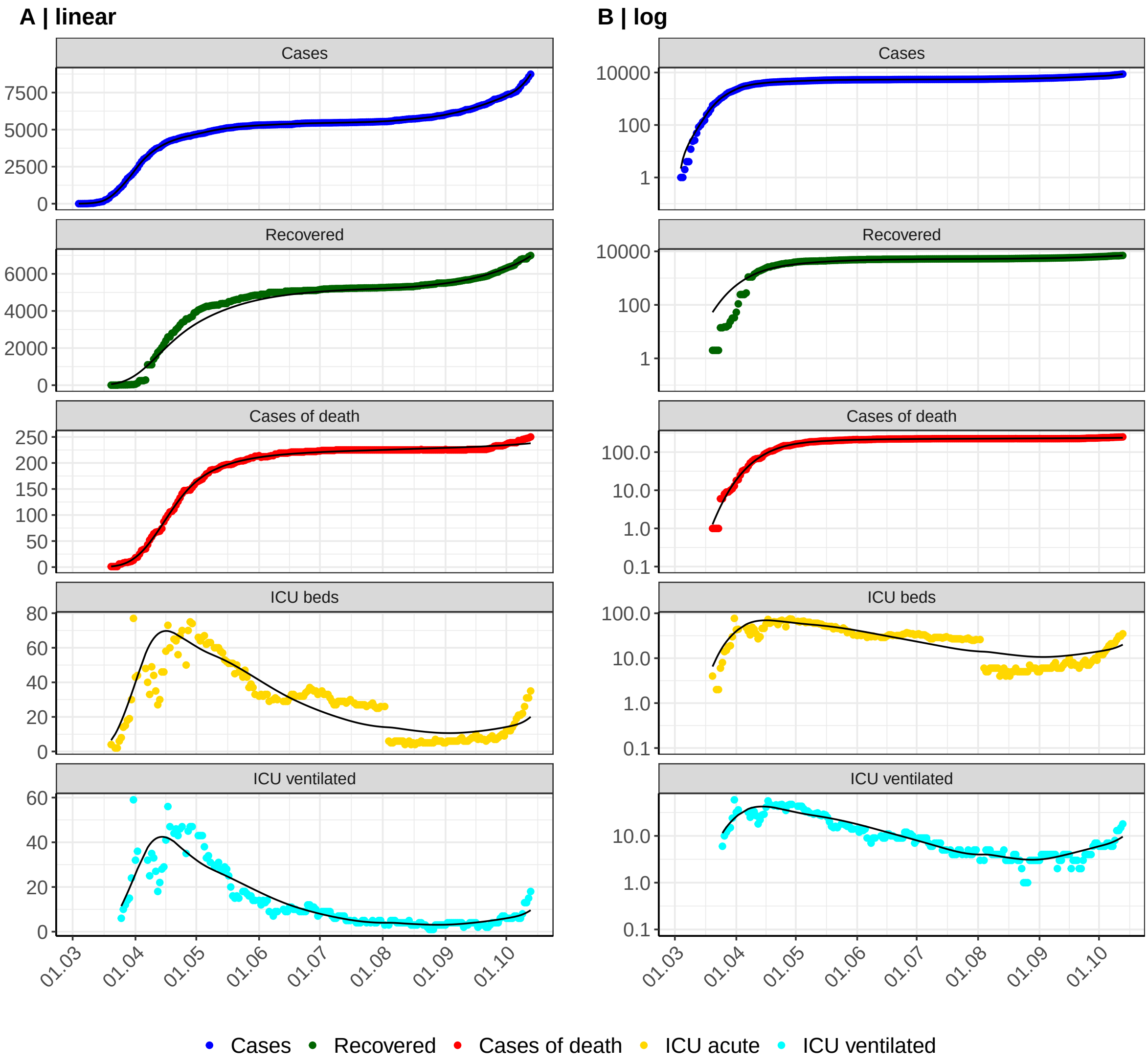



Figure 133: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Saxony. Points: reported data; lines: model description.

Fig. 134 shows the goodness-of-fit for Saxony. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

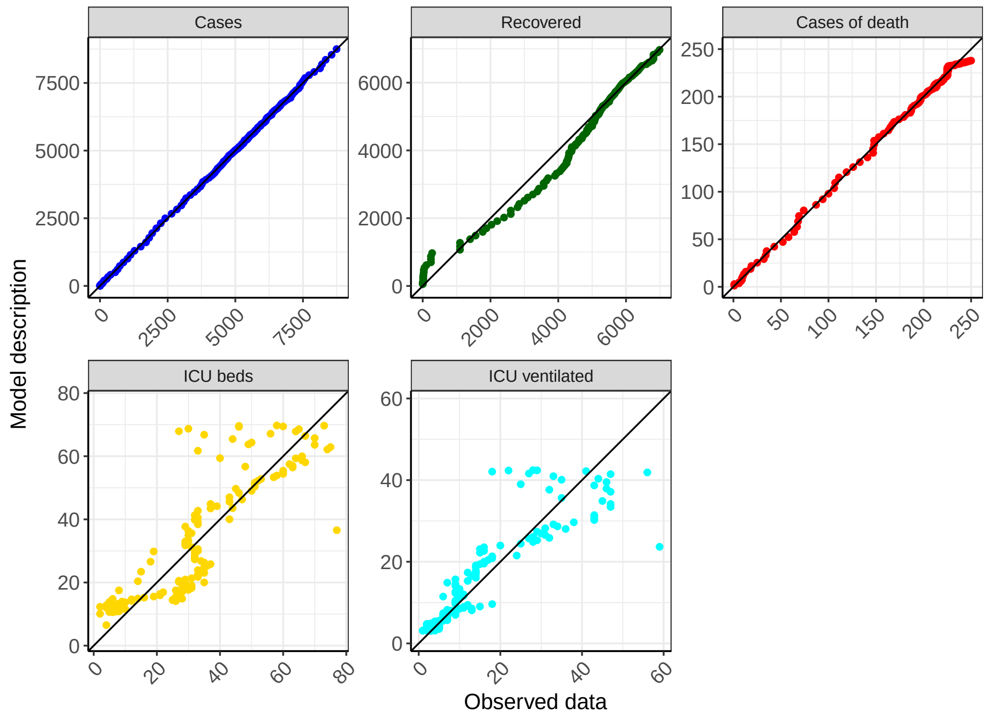



Figure 134: Goodness-of-fit plots for Saxony. Lines: lines of identity.

Fig. 135 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Saxony (red line) in comparison with the other federal states (grey lines).

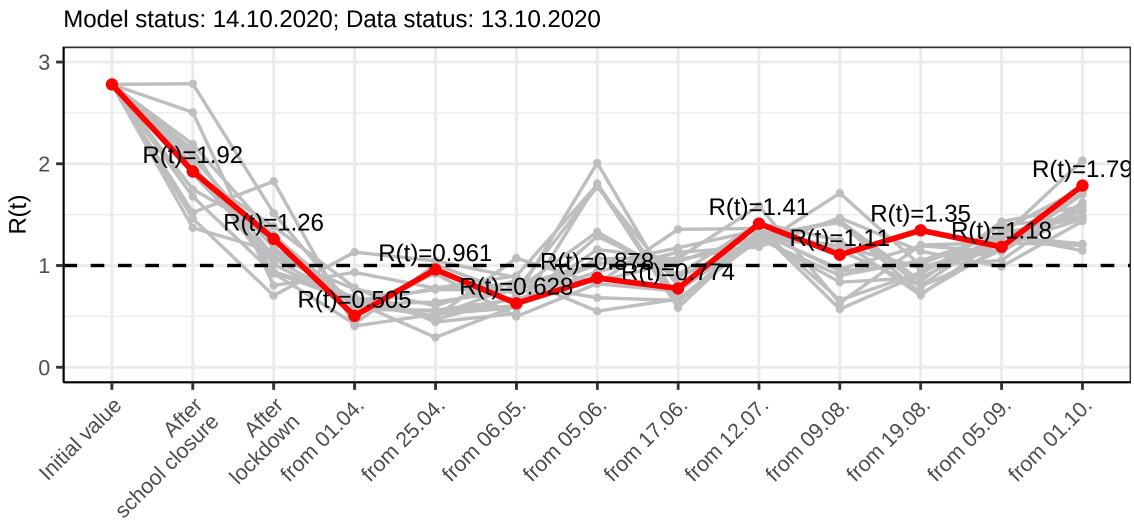



Figure 135: R(t) values before and after the NPIs for Saxony

Fig. 136 shows the R(t) estimated value for Saxony (red line) over time in comparison with the other federal states (grey lines).

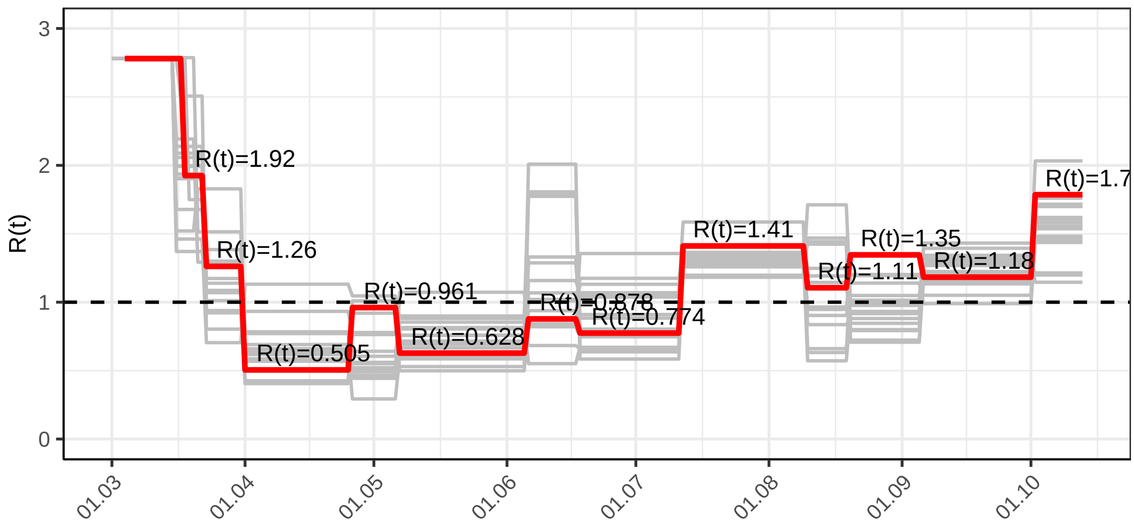



Figure 136: R(t) values over time for Saxony

Fig. 137 shows the changes in hospitalization and death rates for Saxony (red line) over time compared to the other states (grey lines).

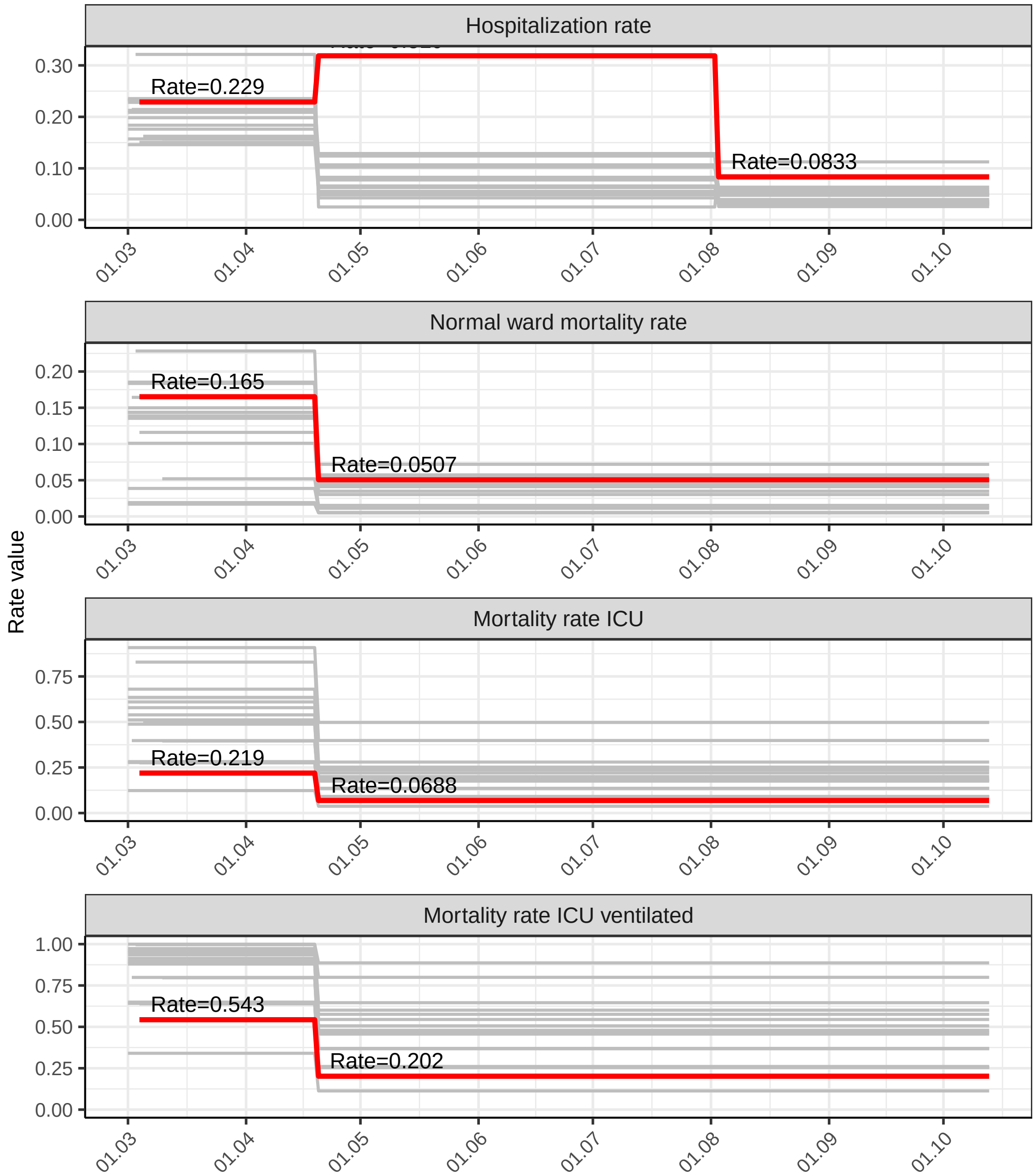



Figure 137: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Saxony

## 14.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.79)

Fig.138 and 139 depict the the model predictions for the next 4 weeks for Saxony on a linear (138) and a semi-logarithmic (139) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

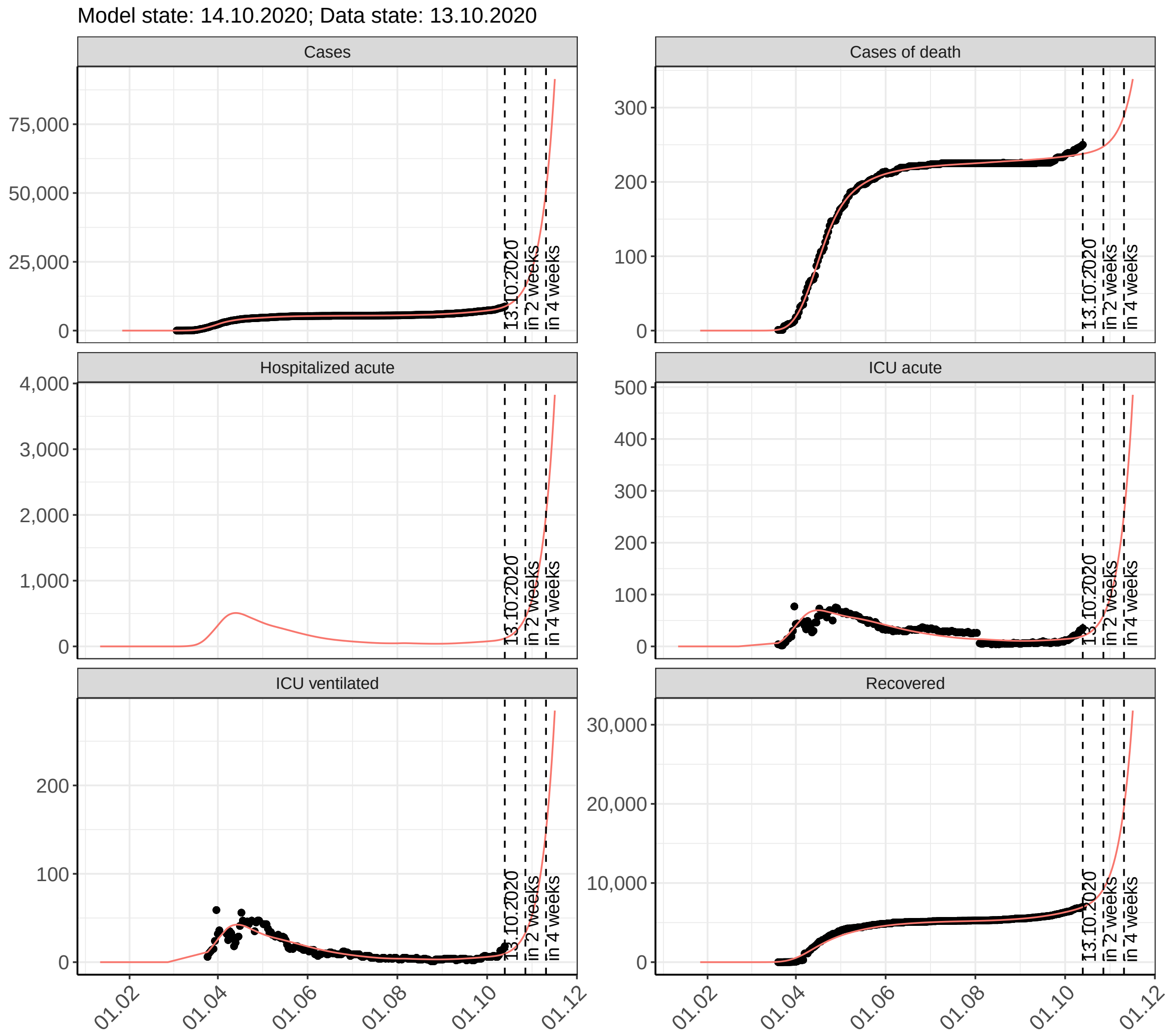



Figure 138: Representation of the model predictions for Saxony for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

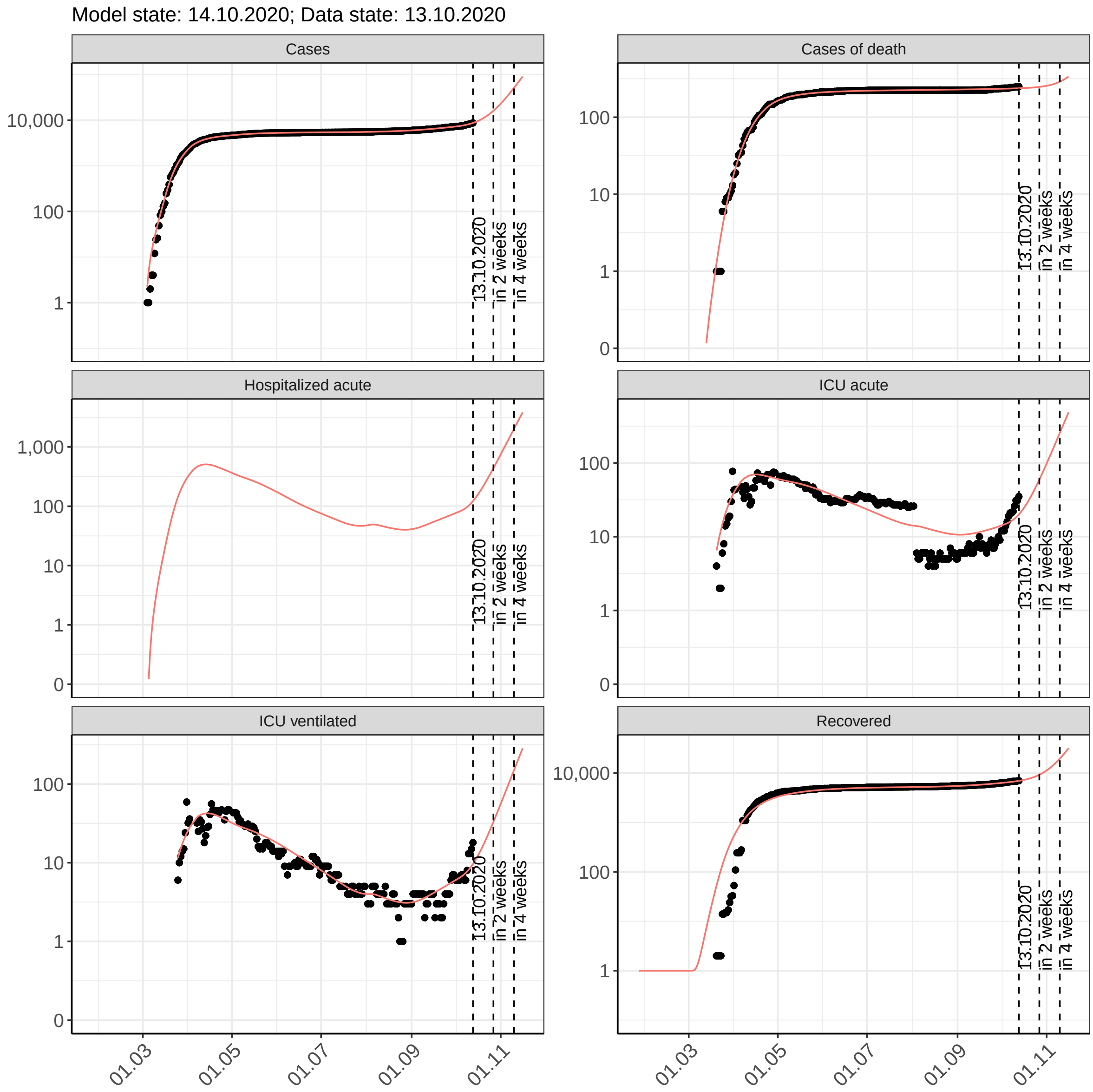



Figure 139: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saxony for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.140 and 141 represent the model prediction for the next 8 weeks for Saxony on a linear (140) and a semi-logarithmic (141) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

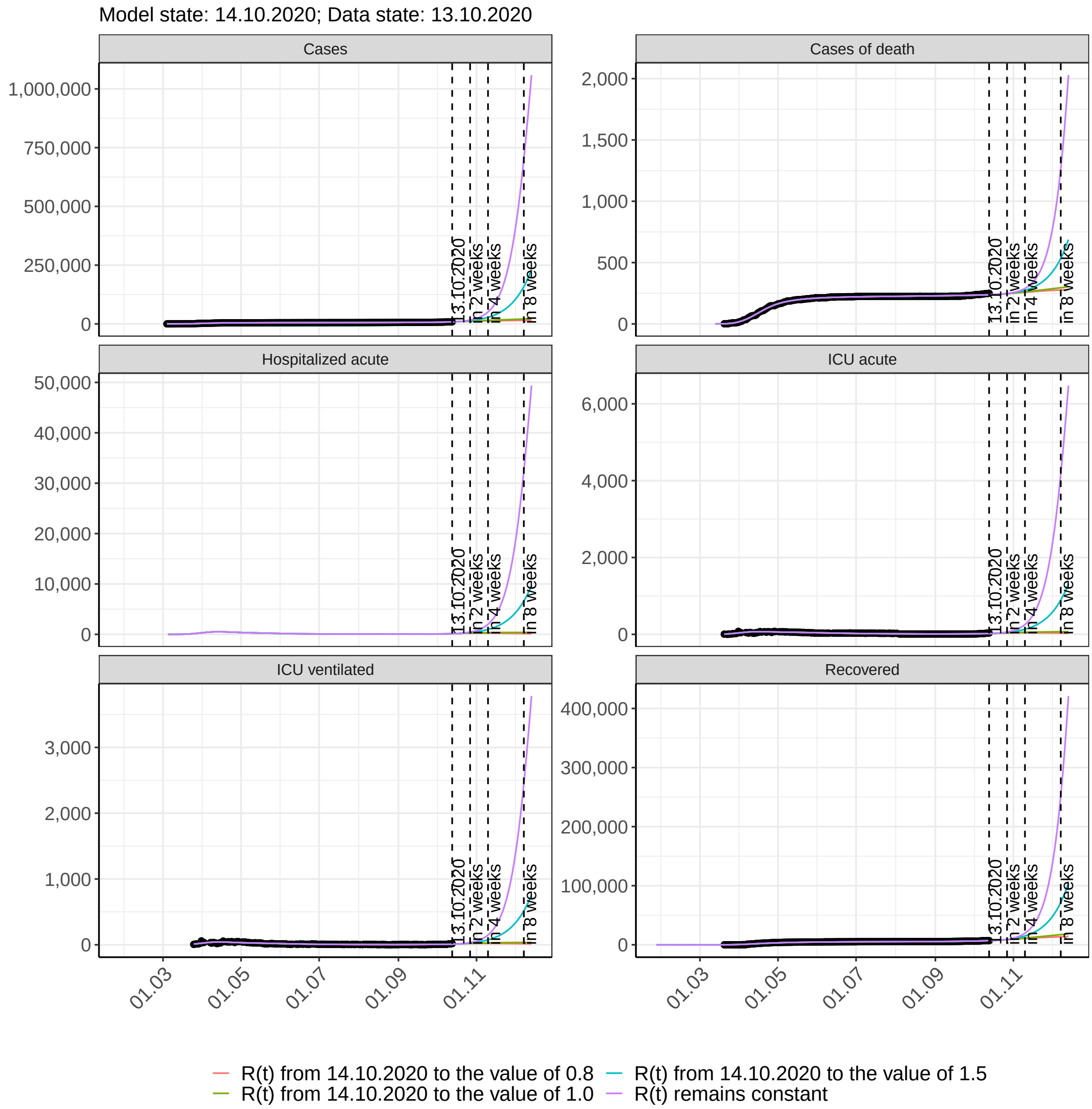



Figure 140: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saxony assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

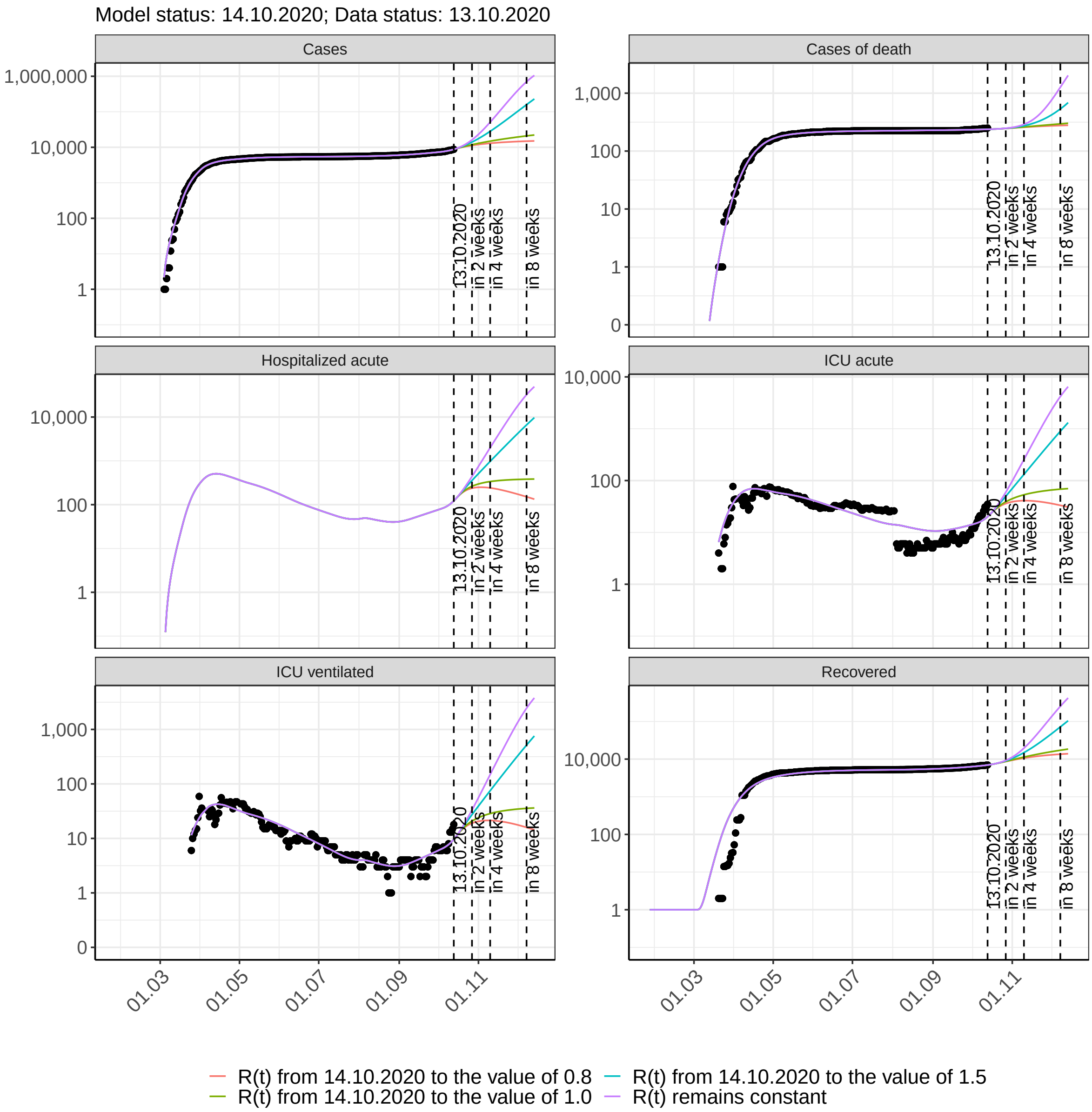



Figure 141: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saxony assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 142 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

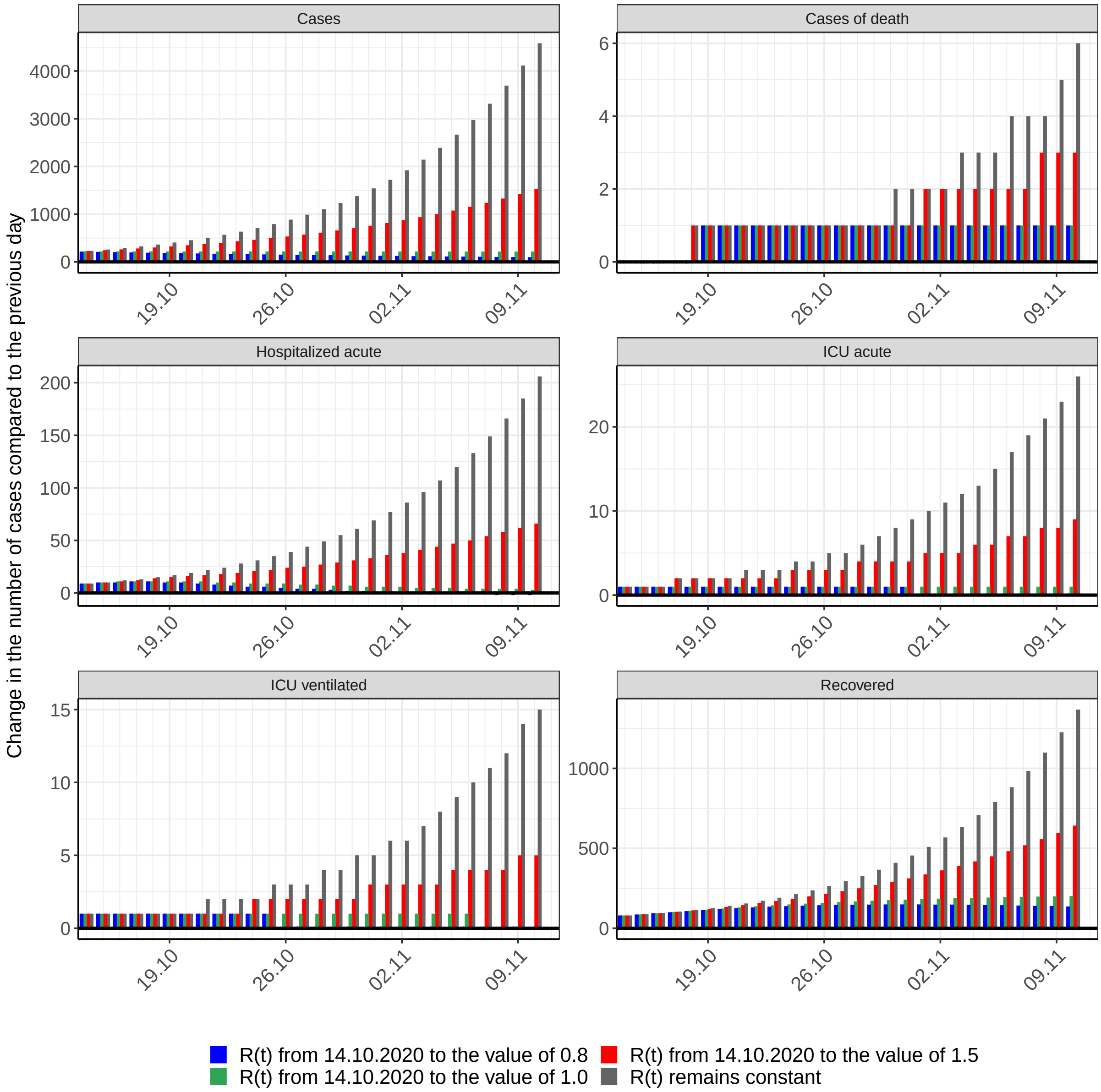



Figure 142: Simulation of daily new cases for the next 4 weeks - Saxony

# 15 Saxony-Anhalt

## 15.1 Model description

Fig. 143 depicts the results of the modeling (lines) compared to the observed data (points) for Saxony-Anhalt on a linear (A) and semi-logarithmic (B) scale.

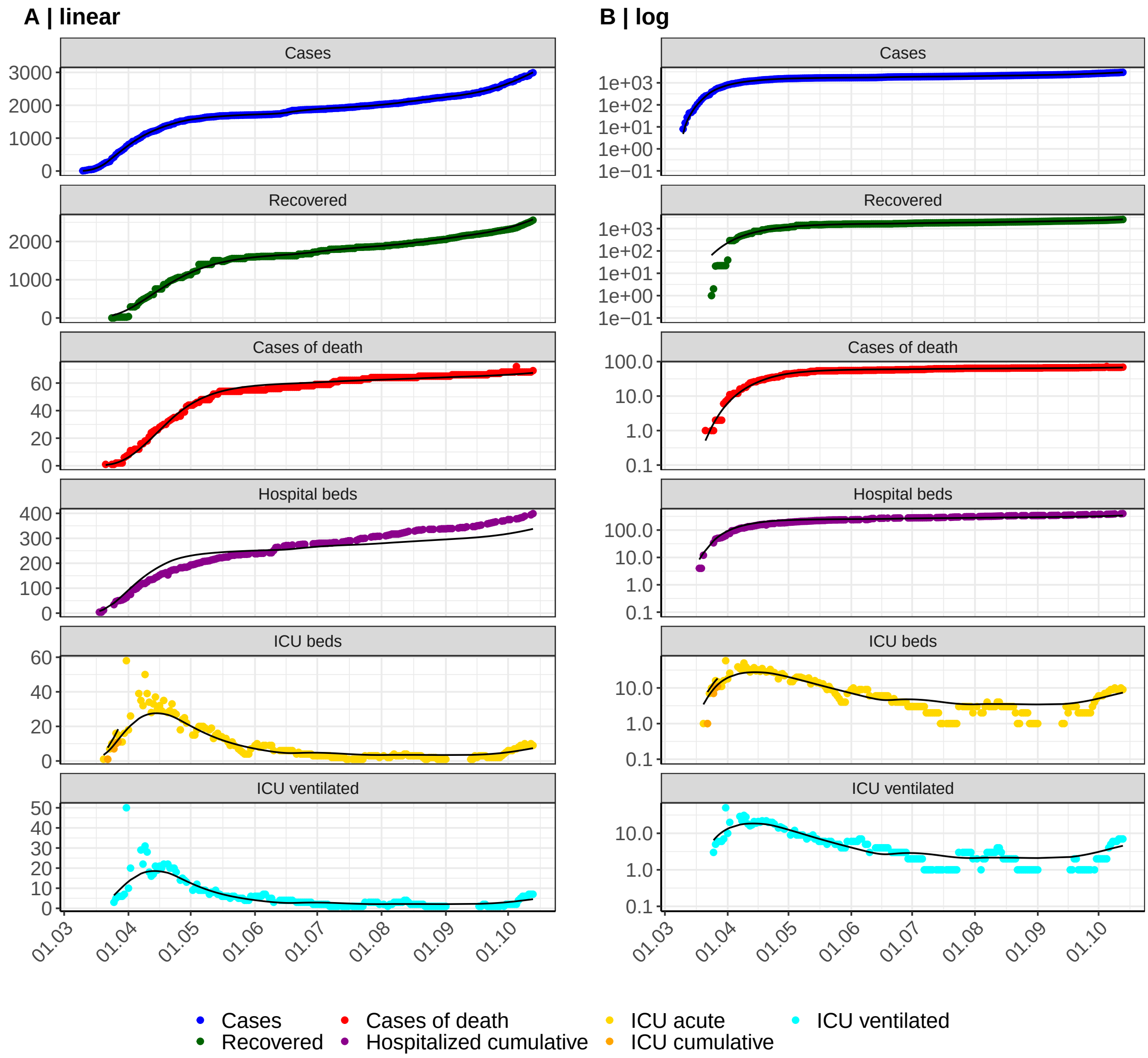



Figure 143: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Saxony-Anhalt. Points: reported data; lines: model description.

Fig. 144 shows the goodness-of-fit for Saxony-Anhalt. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

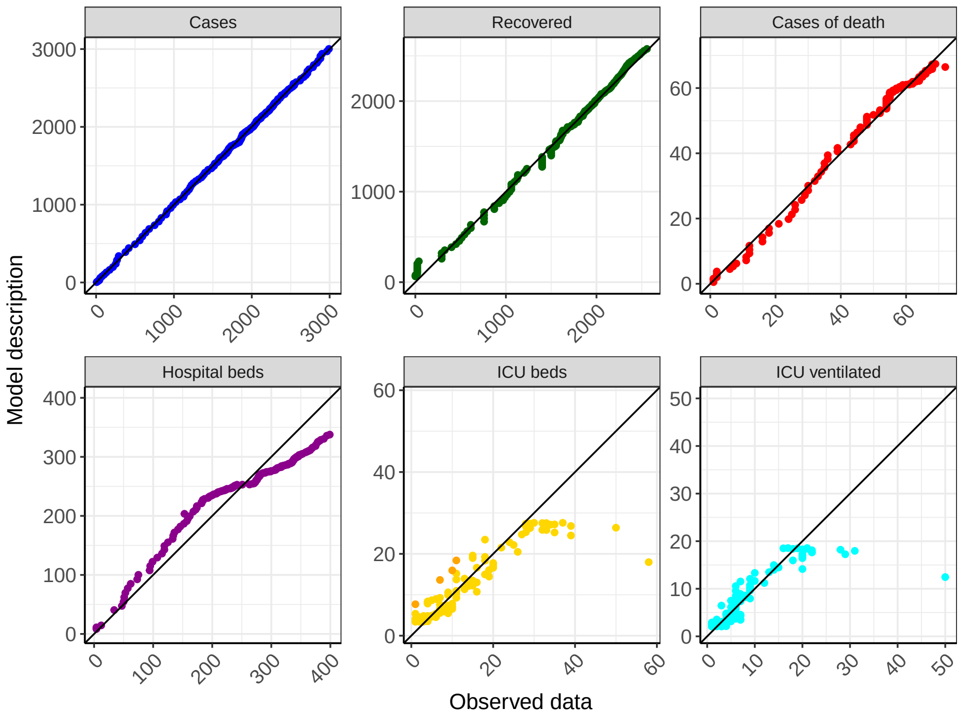



Figure 144: Goodness-of-fit plots for Saxony-Anhalt. Lines: lines of identity.

Fig. 145 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Saxony-Anhalt (red line) in comparison with the other federal states (grey lines).

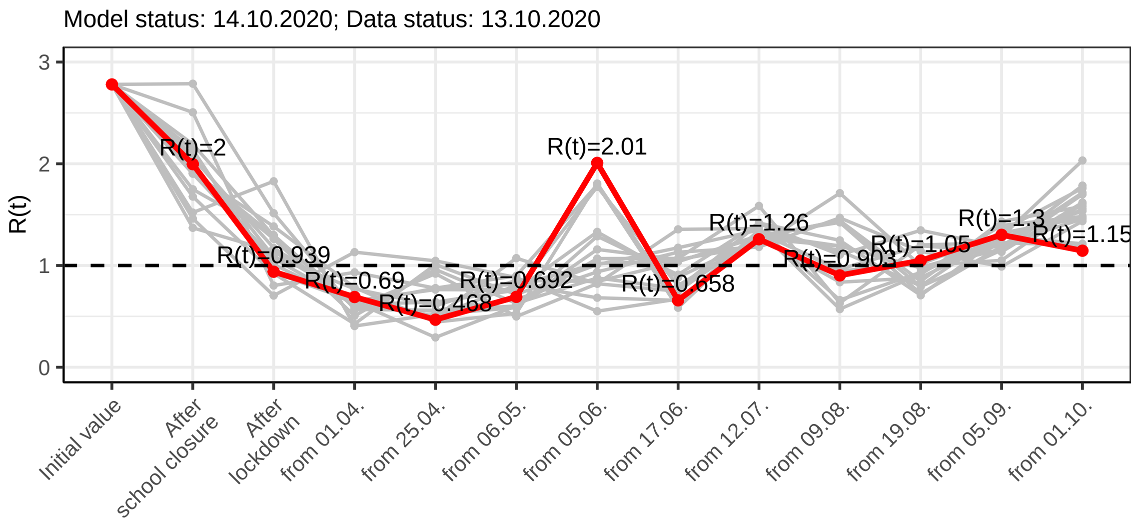



Figure 145: R(t) values before and after the NPIs for Saxony-Anhalt

Fig. 146 shows the R(t) estimated value for Saxony-Anhalt (red line) over time in comparison with the other federal states (grey lines).

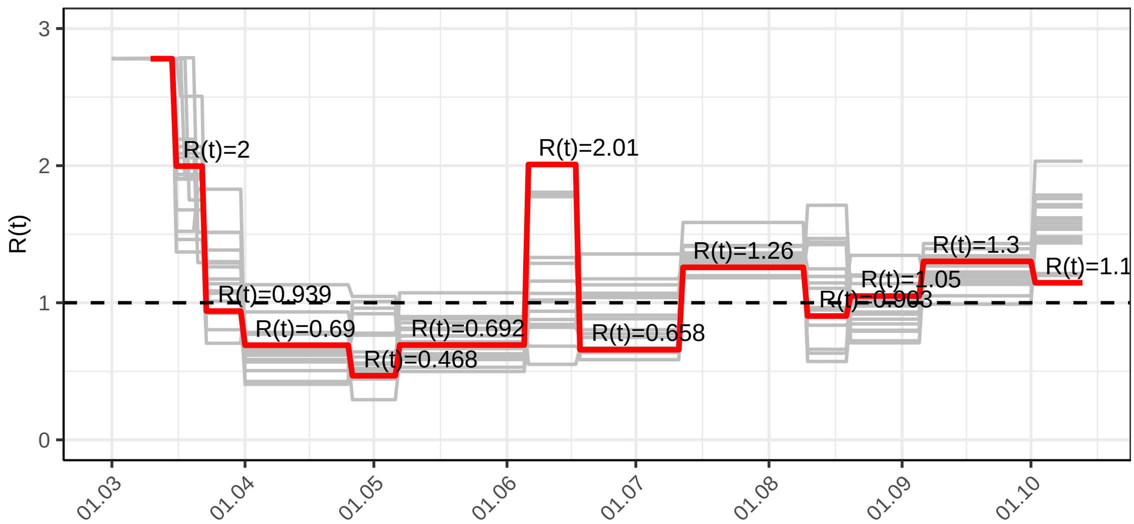



Figure 146: R(t) values over time for Saxony-Anhalt

Fig. 147 shows the changes in hospitalization and death rates for Saxony-Anhalt (red line) over time compared to the other states (grey lines).

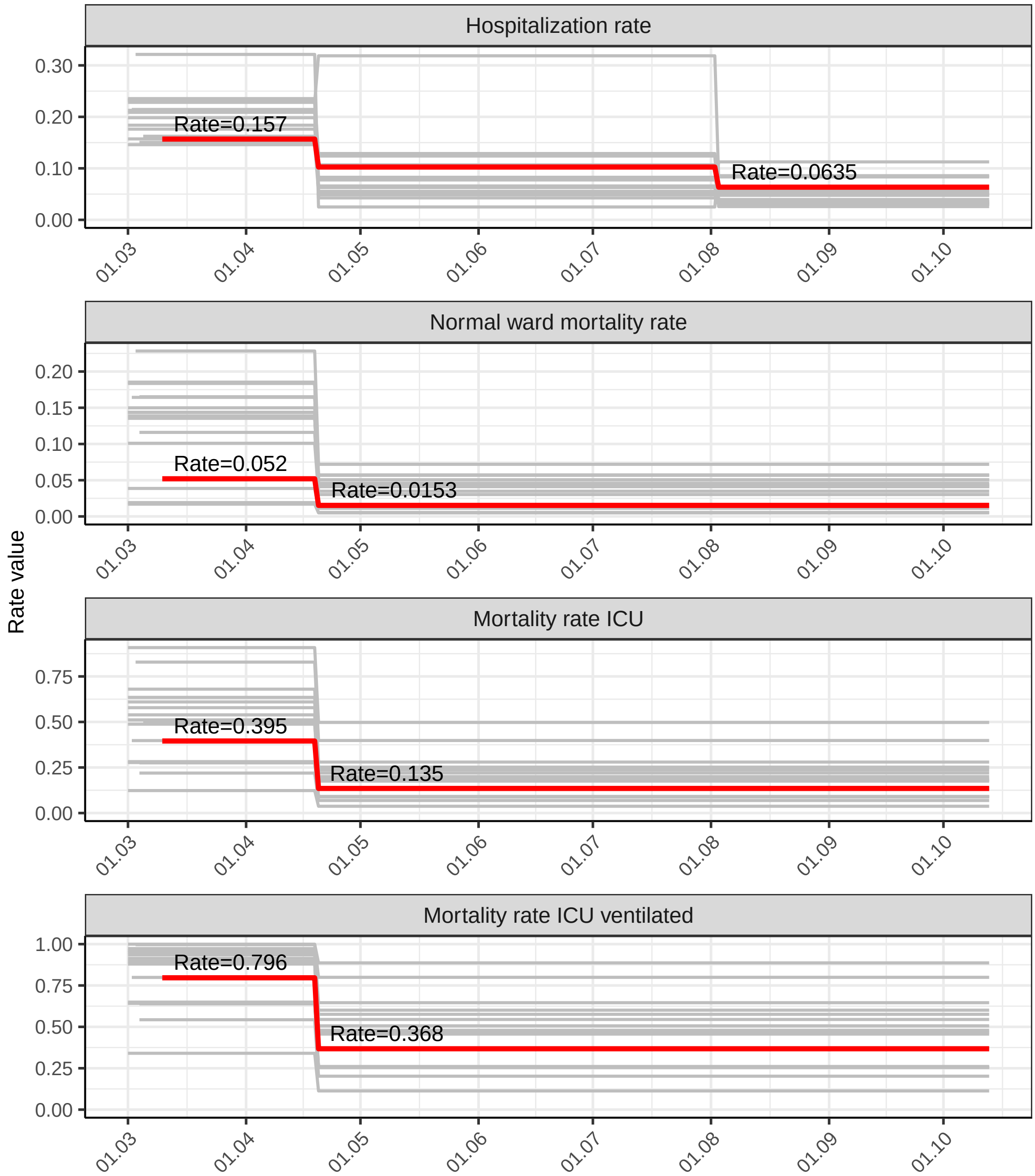



Figure 147: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Saxony-Anhalt

## 15.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.15)

Fig.148 and 149 depict the the model predictions for the next 4 weeks for Saxony-Anhalt on a linear (148) and a semi-logarithmic (149) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

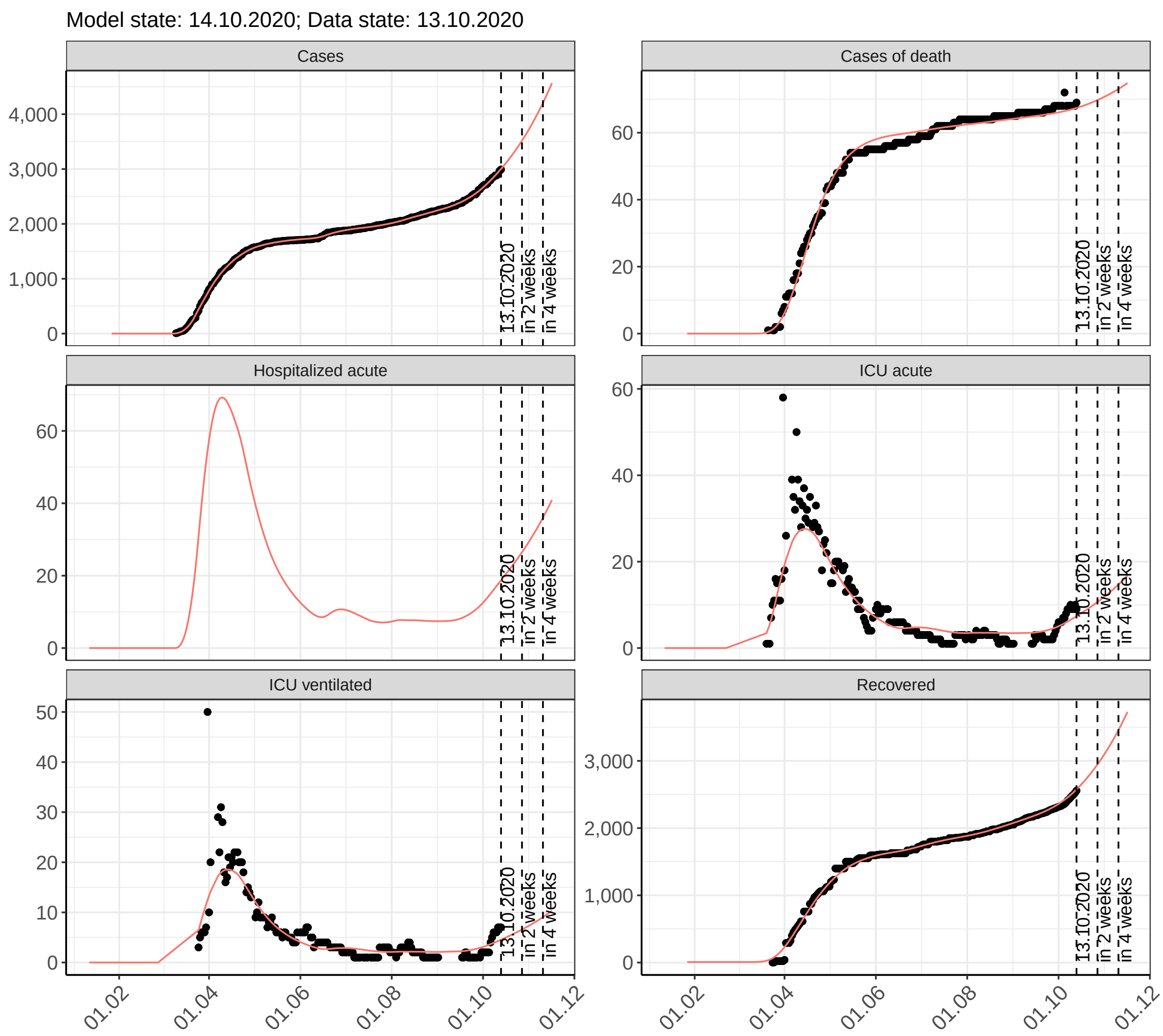



Figure 148: Representation of the model predictions for Saxony-Anhalt for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

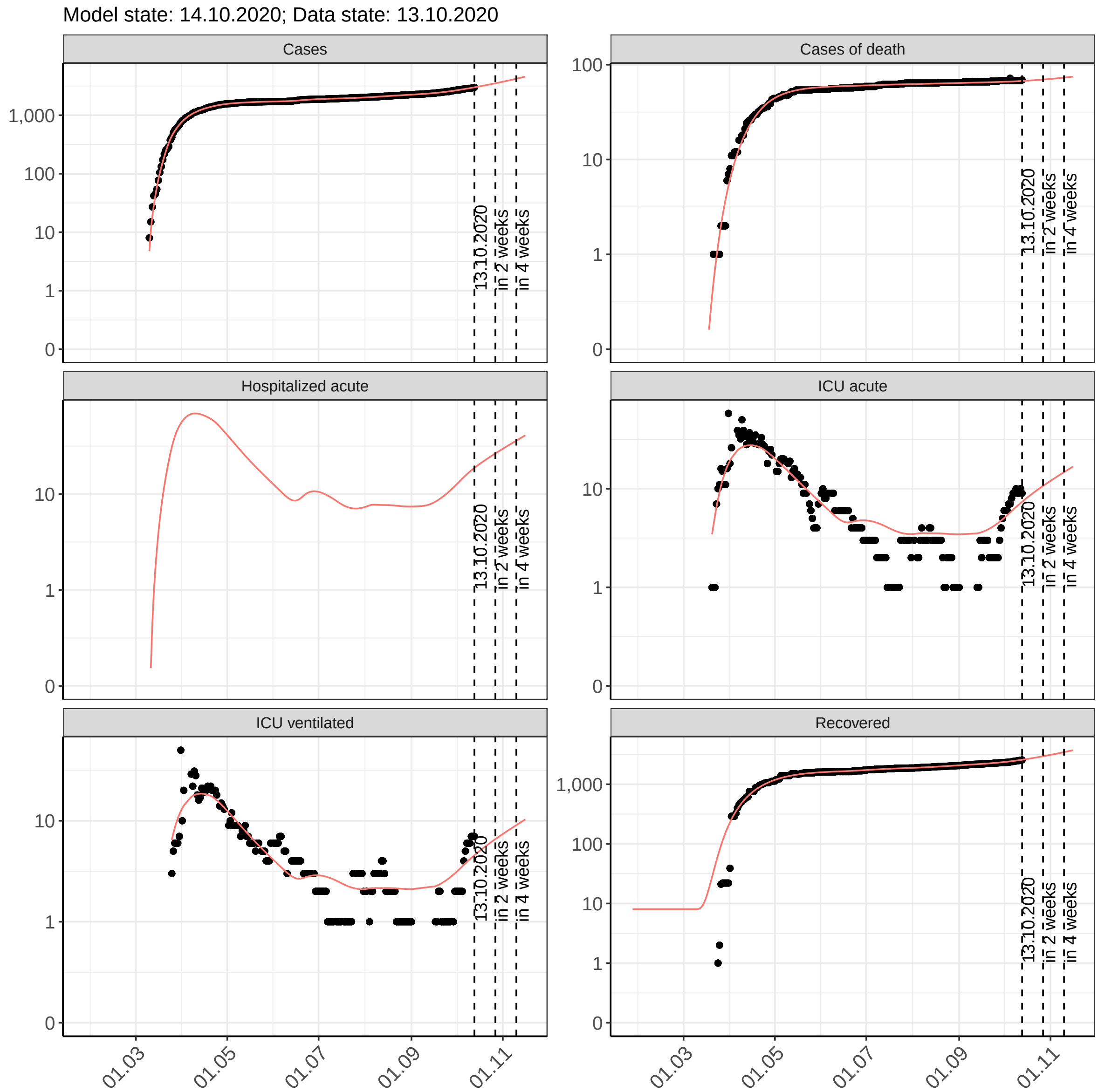



Figure 149: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saxony-Anhalt for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.150 and 151 represent the model prediction for the next 8 weeks for Saxony-Anhalt on a linear (150) and a semi-logarithmic (151) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

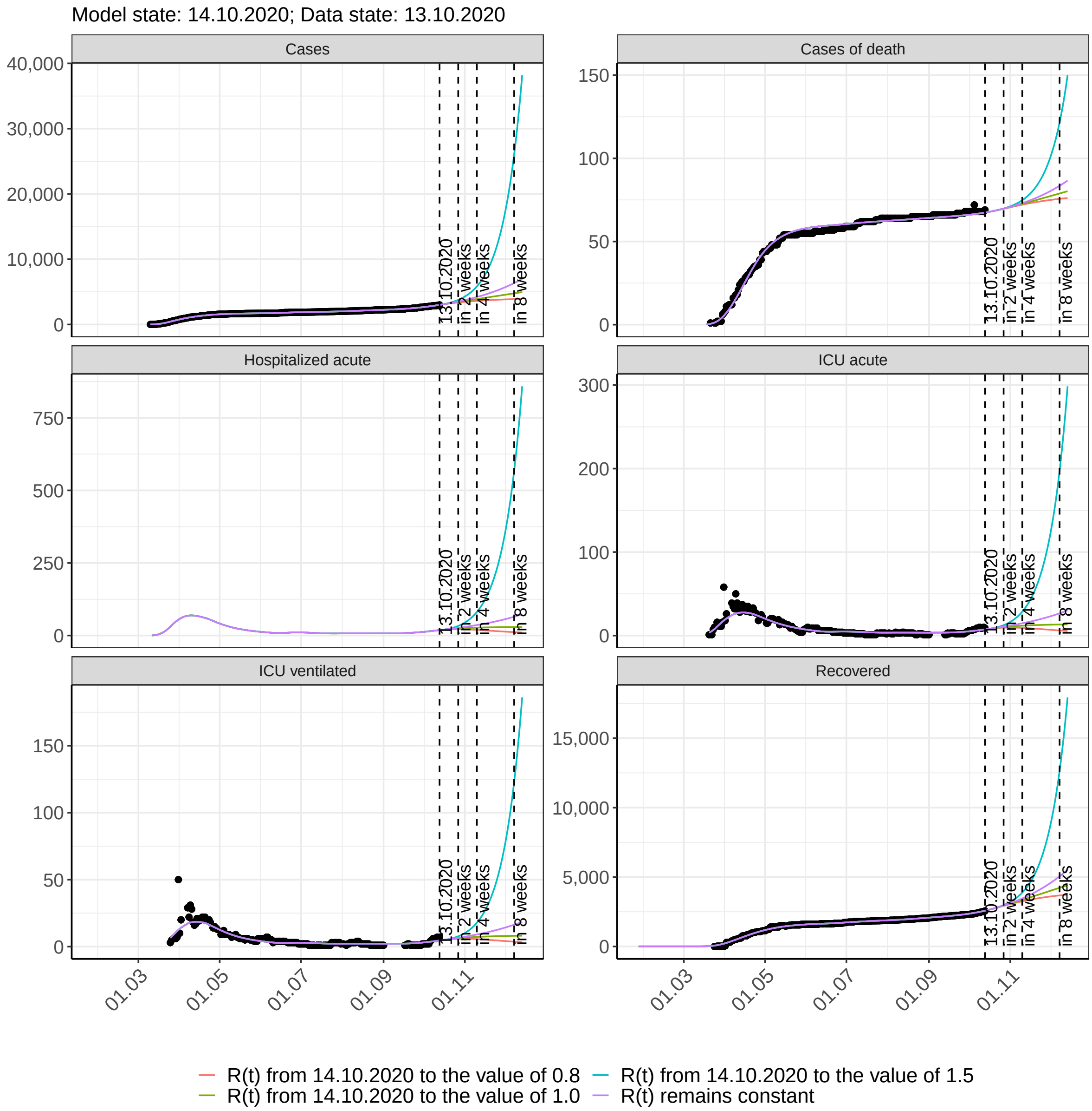



Figure 150: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saxony-Anhalt assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

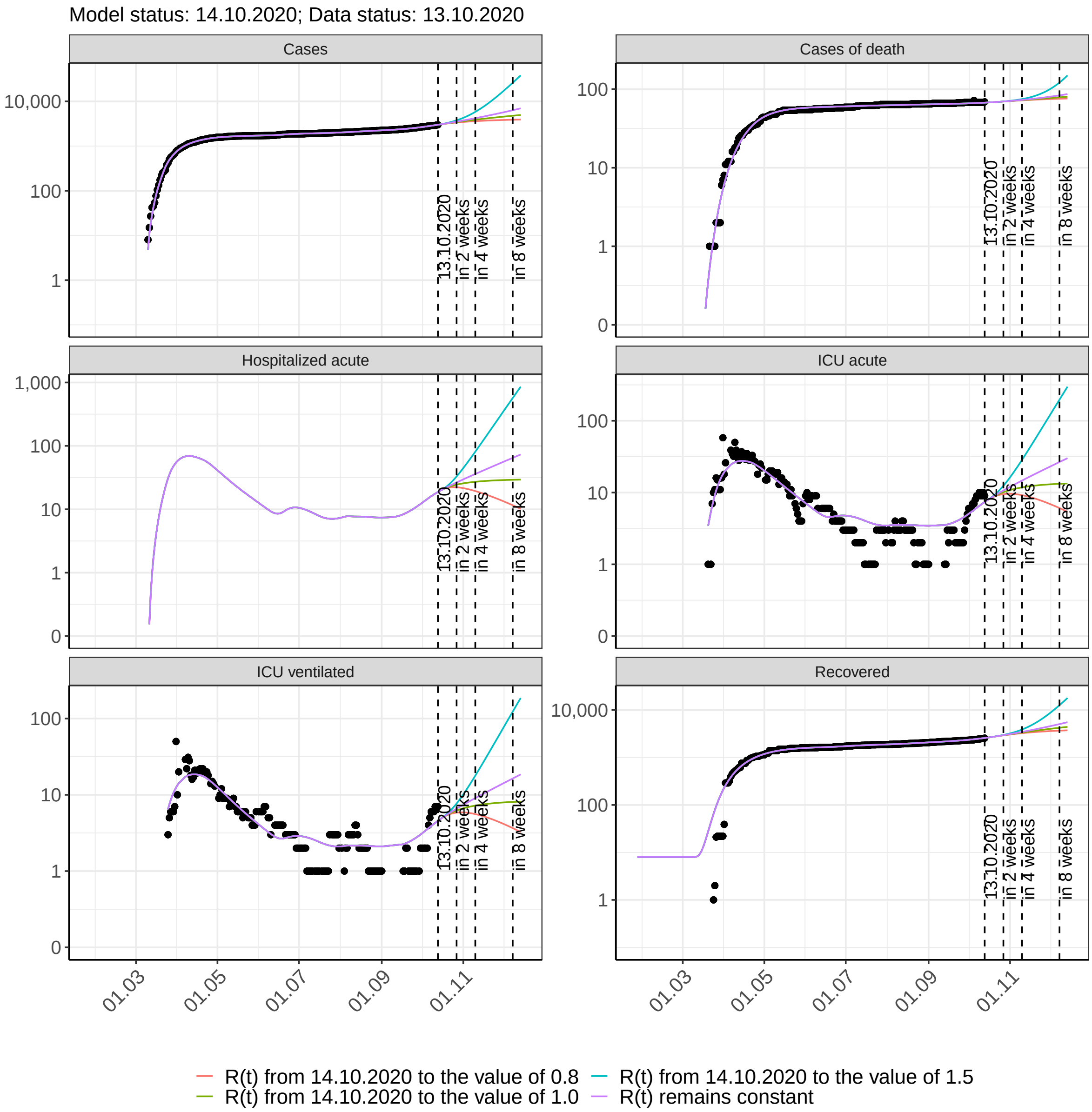



Figure 151: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Saxony-Anhalt assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 152 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

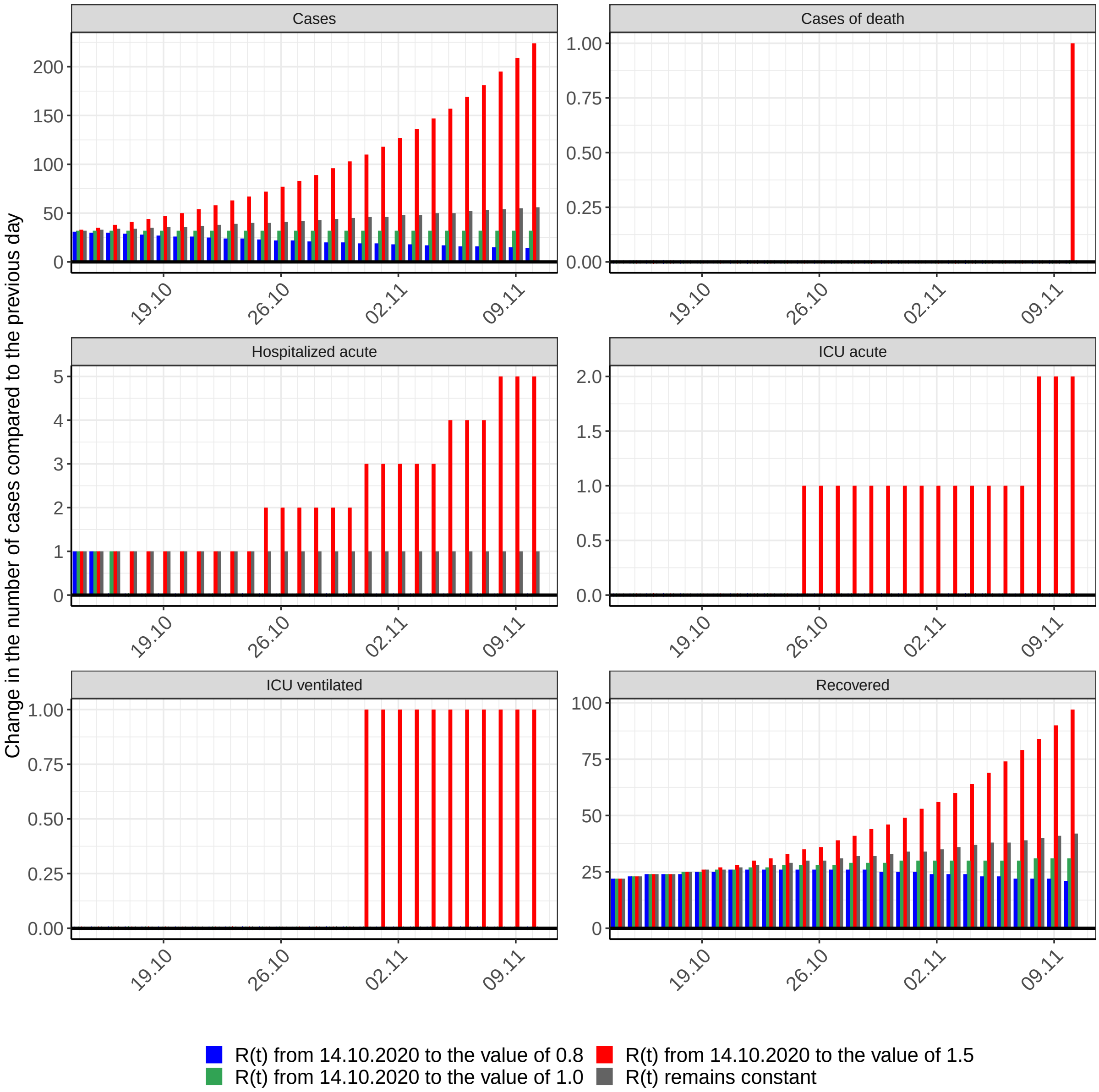



Figure 152: Simulation of daily new cases for the next 4 weeks - Saxony-Anhalt

# 16 Schleswig-Holstein

## 16.1 Model description

Fig. 153 depicts the results of the modeling (lines) compared to the observed data (points) for Schleswig-Holstein on a linear (A) and semi-logarithmic (B) scale.

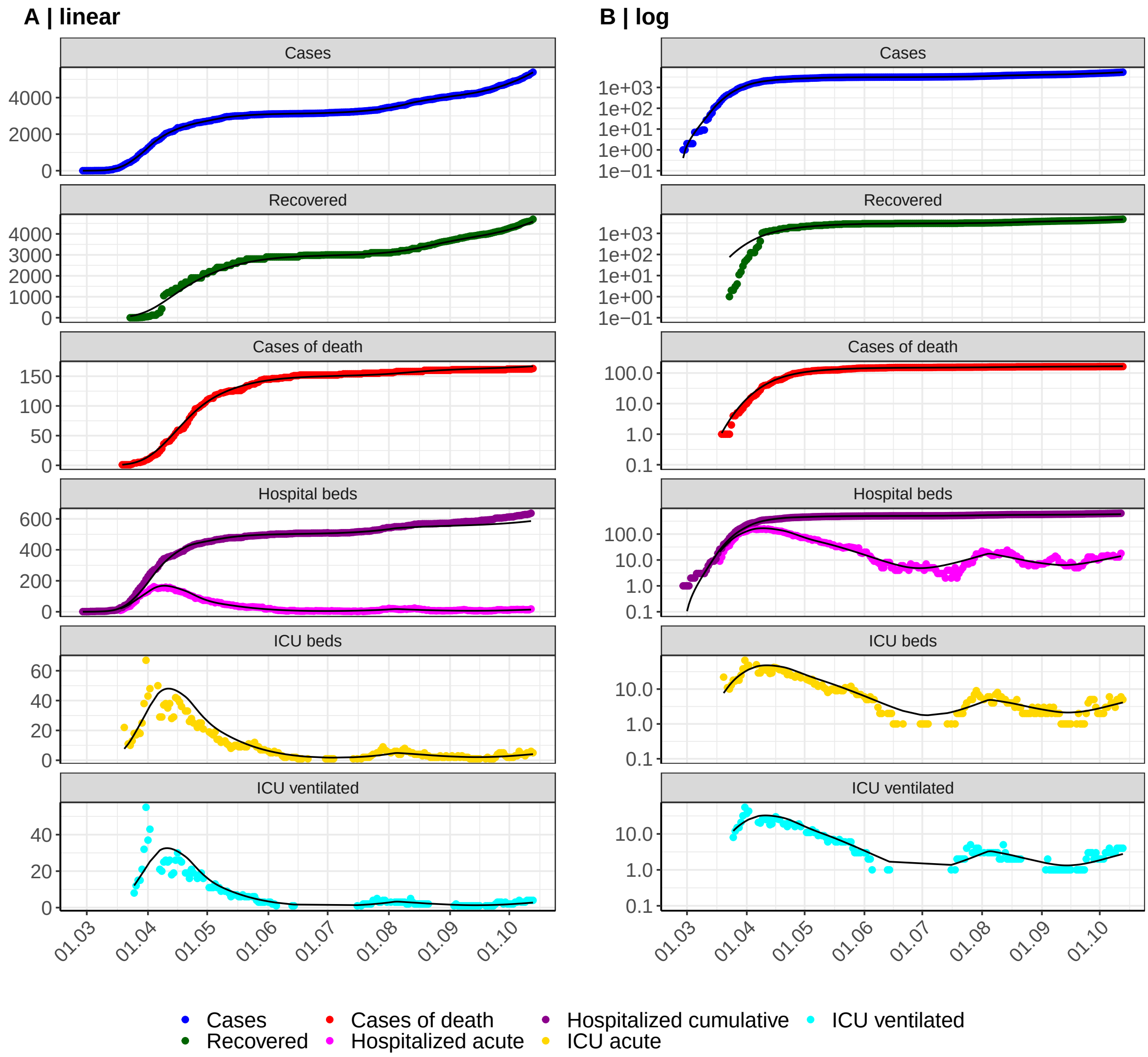



Figure 153: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Schleswig-Holstein. Points: reported data; lines: model description.

Fig. 154 shows the goodness-of-fit for Schleswig-Holstein. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

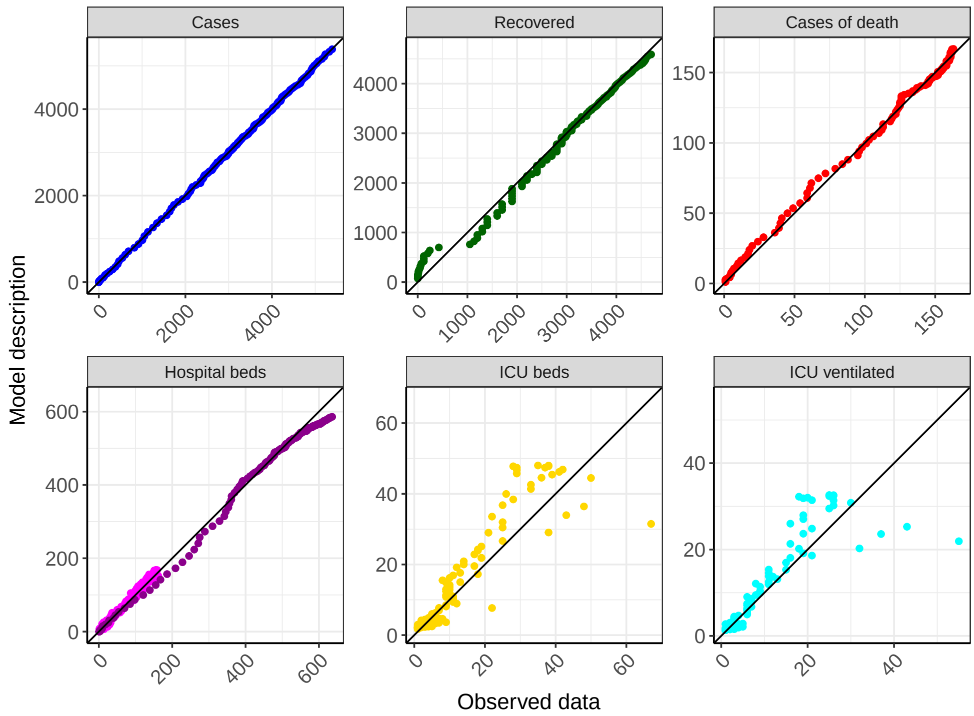



Figure 154: Goodness-of-fit plots for Schleswig-Holstein. Lines: lines of identity.

Fig. 155 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Schleswig-Holstein (red line) in comparison with the other federal states (grey lines).

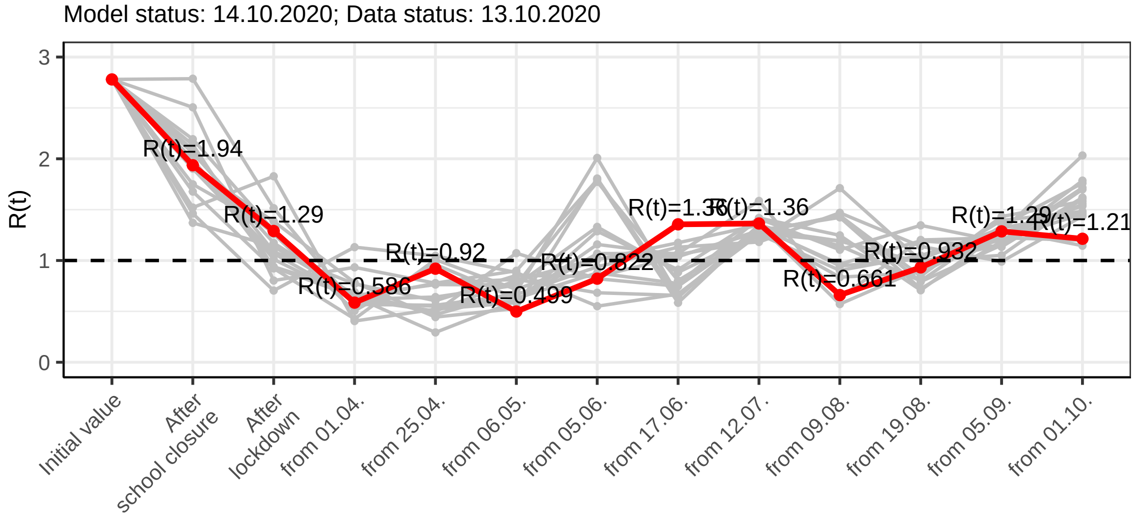



Figure 155: R(t) values before and after the NPIs for Schleswig-Holstein

Fig. 156 shows the R(t) estimated value for Schleswig-Holstein (red line) over time in comparison with the other federal states (grey lines).

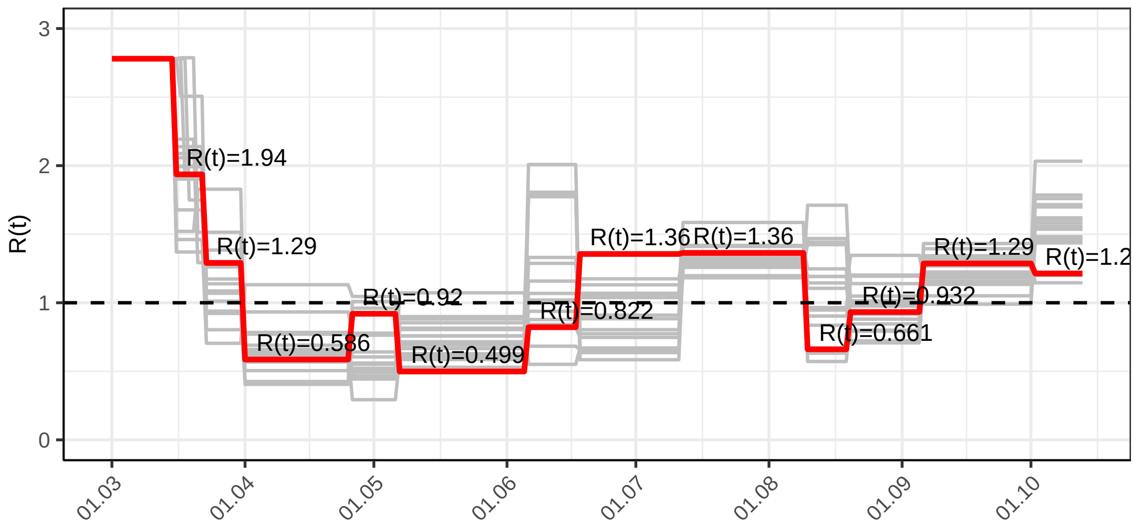



Figure 156: R(t) values over time for Schleswig-Holstein

Fig. 157 shows the changes in hospitalization and death rates for Schleswig-Holstein (red line) over time compared to the other states (grey lines).

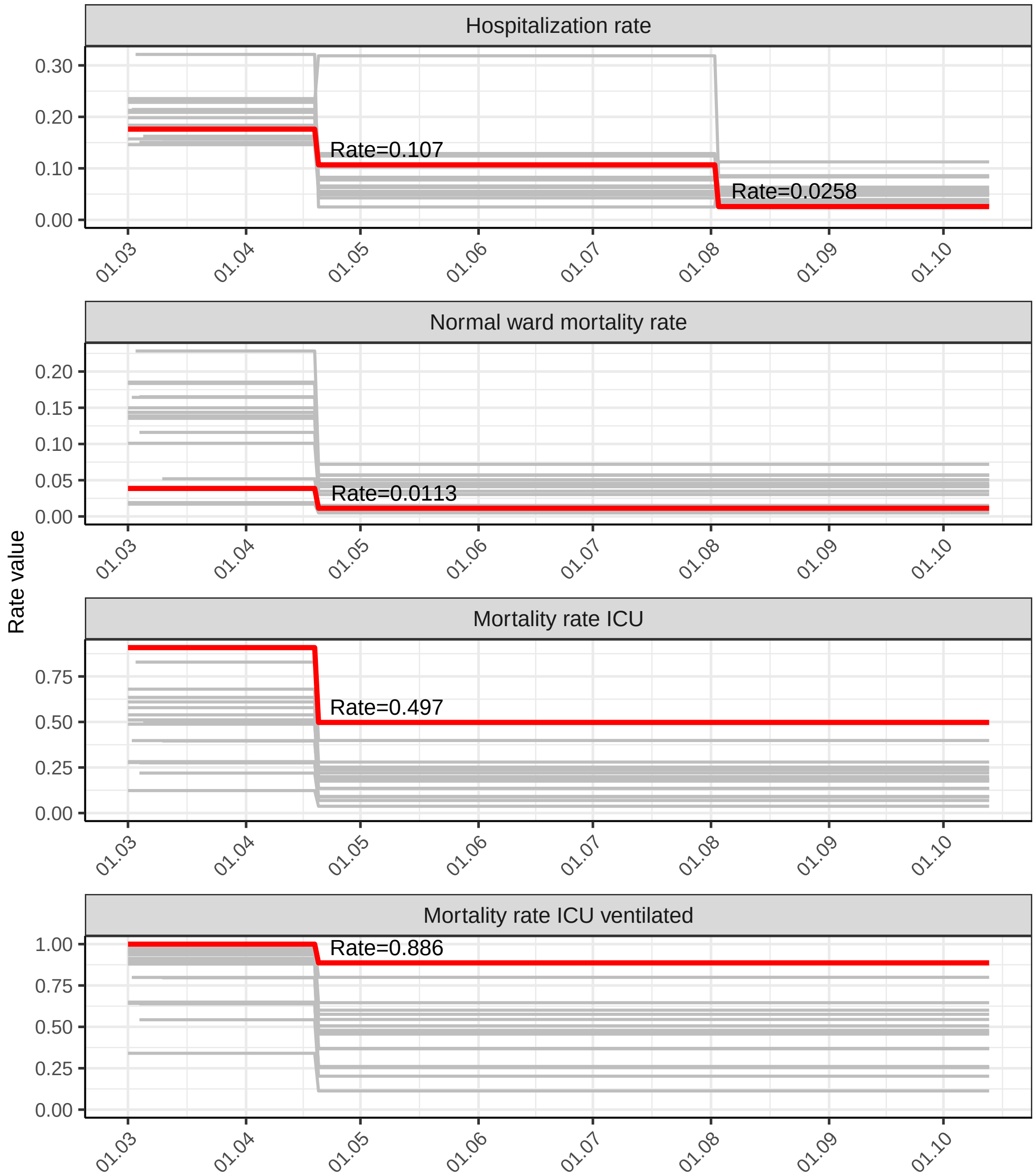



Figure 157: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Schleswig-Holstein

## 16.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.21)

Fig.158 and 159 depict the the model predictions for the next 4 weeks for Schleswig-Holstein on a linear (158) and a semi-logarithmic (159) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

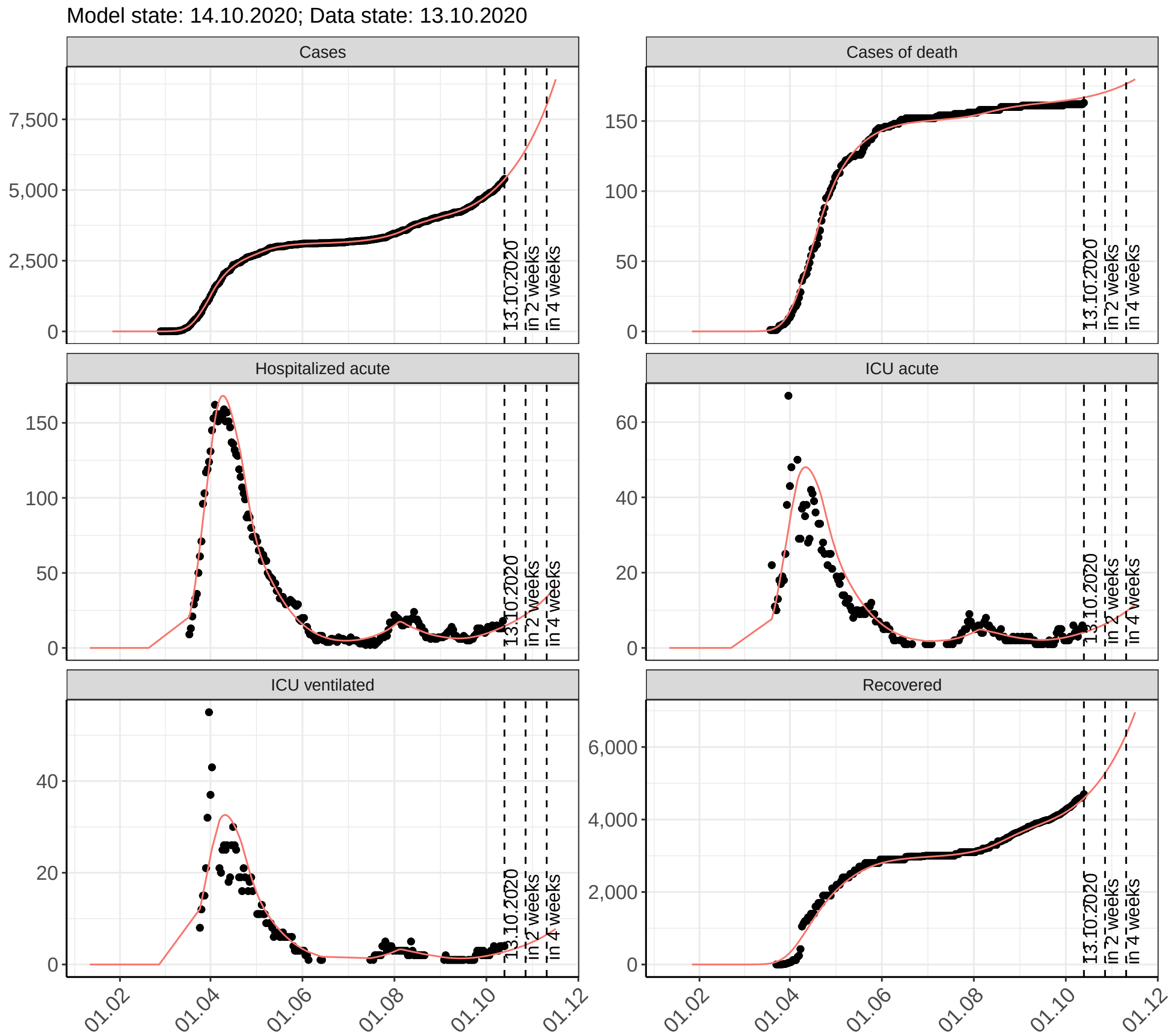



Figure 158: Representation of the model predictions for Schleswig-Holstein for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

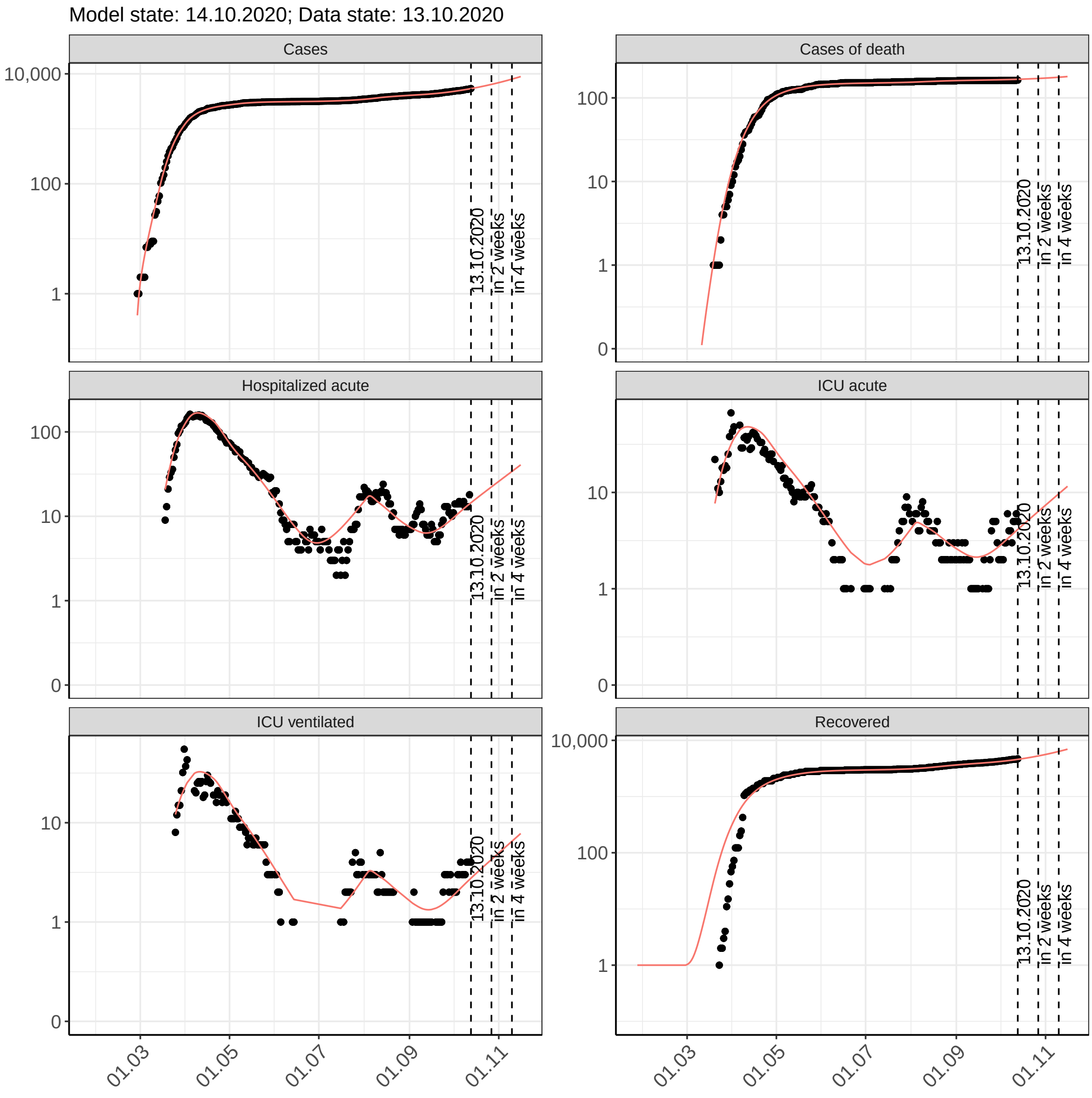



Figure 159: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Schleswig-Holstein for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.160 and 161 represent the model prediction for the next 8 weeks for Schleswig-Holstein on a linear (160) and a semi-logarithmic (161) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

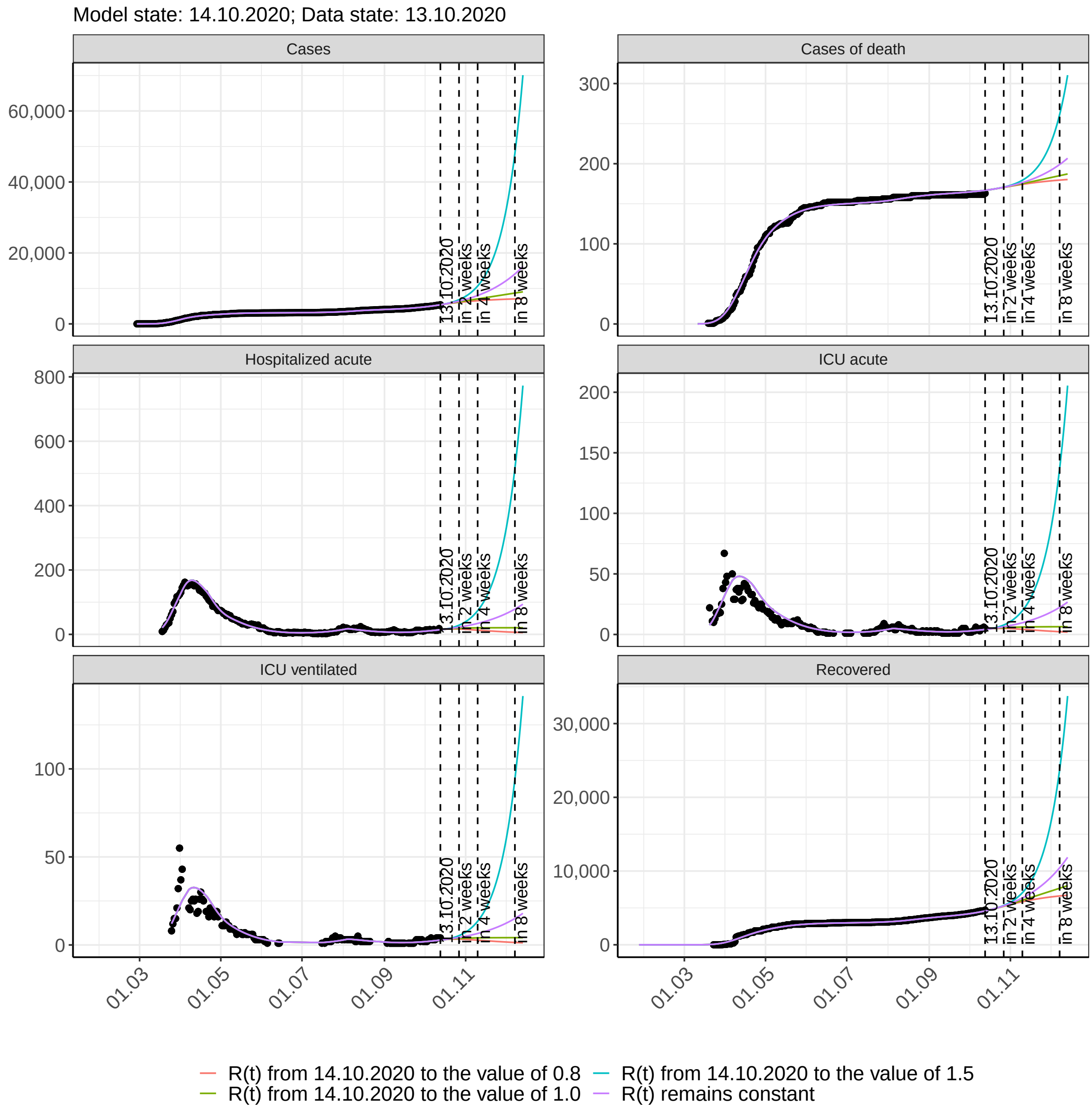



Figure 160: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Schleswig-Holstein assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

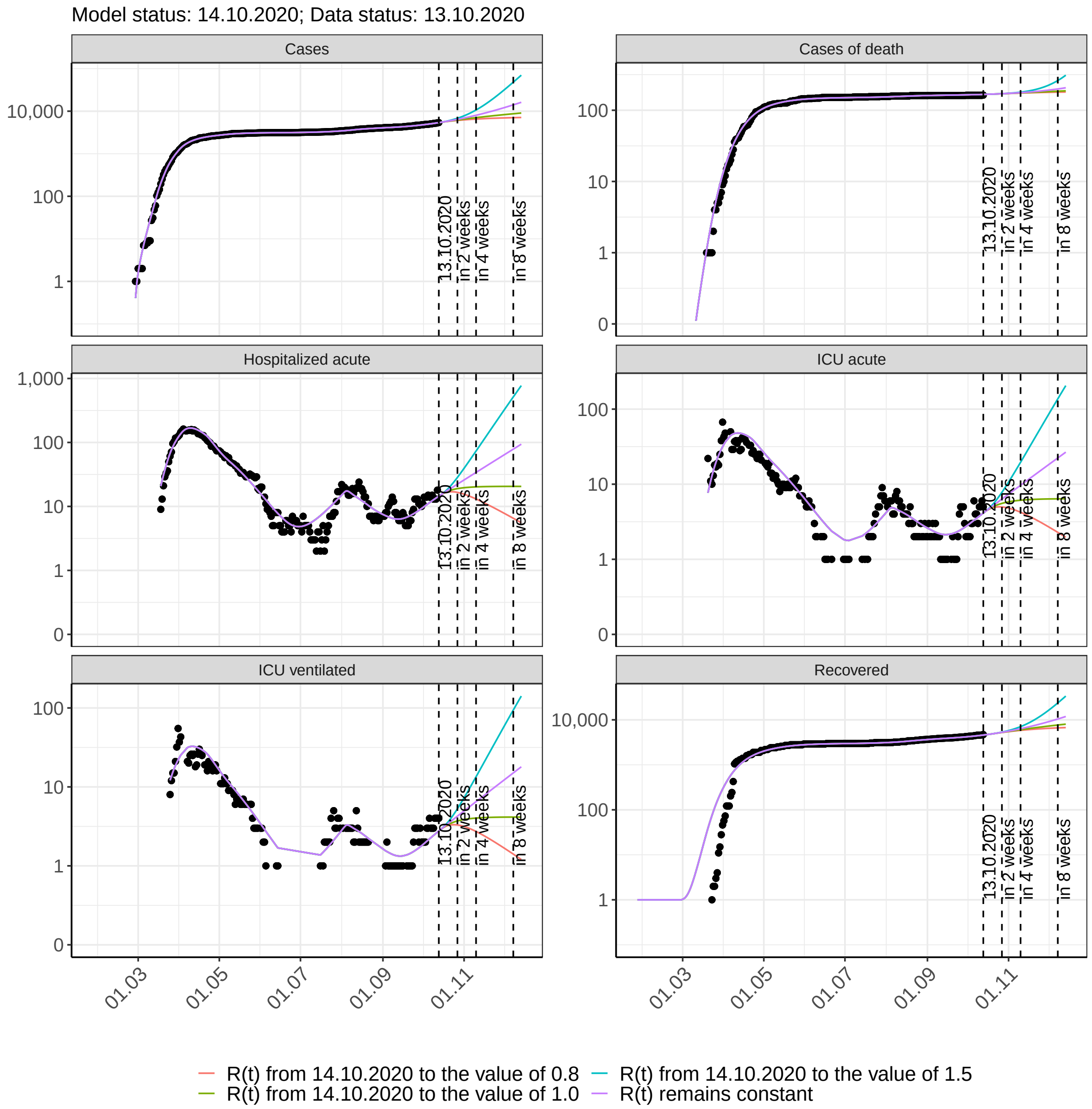



Figure 161: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Schleswig-Holstein assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 162 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

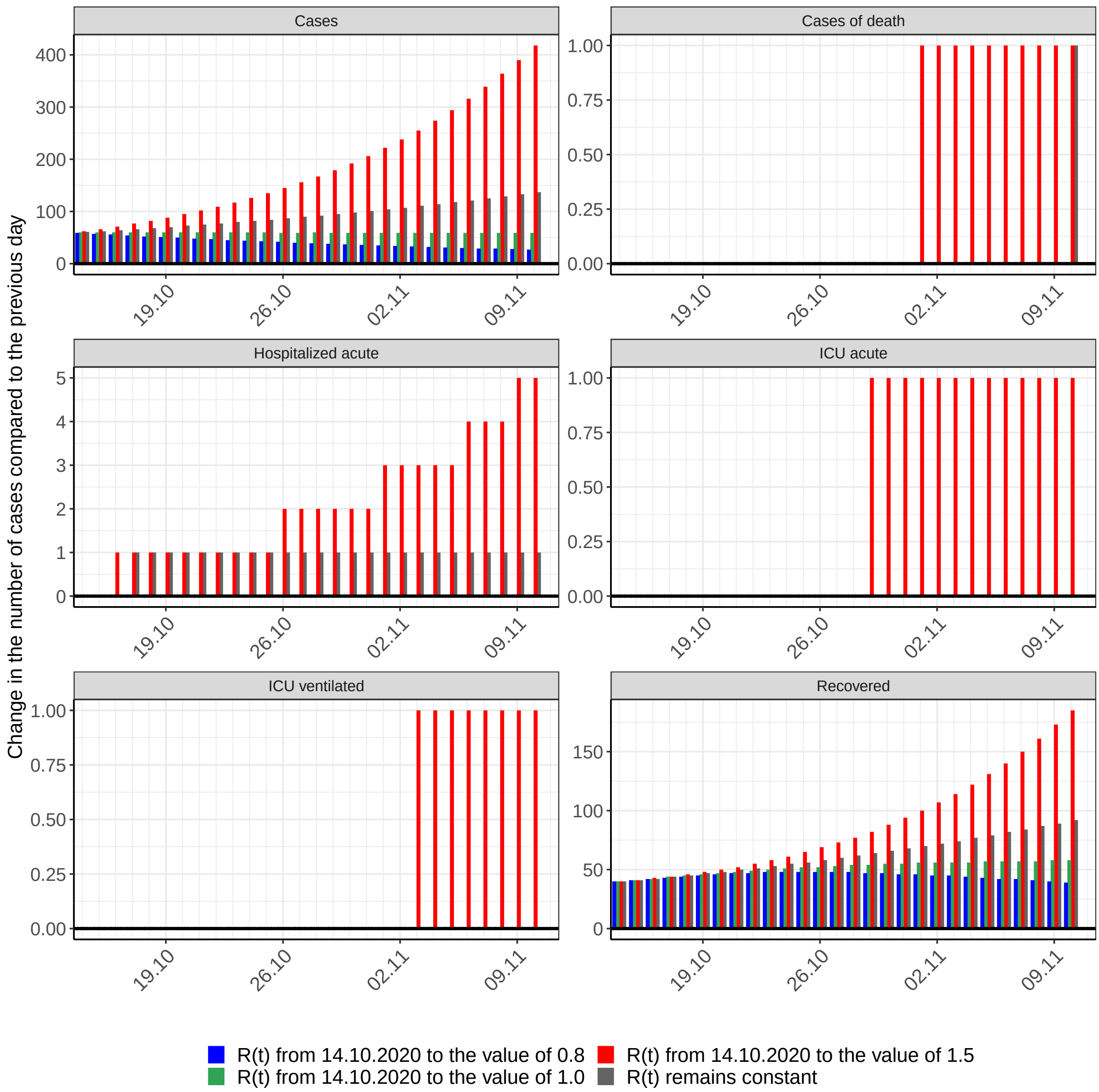



Figure 162: Simulation of daily new cases for the next 4 weeks - Schleswig-Holstein

# 17 Thuringia

## 17.1 Model description

Fig. 163 depicts the results of the modeling (lines) compared to the observed data (points) for Thuringia on a linear (A) and semi-logarithmic (B) scale.

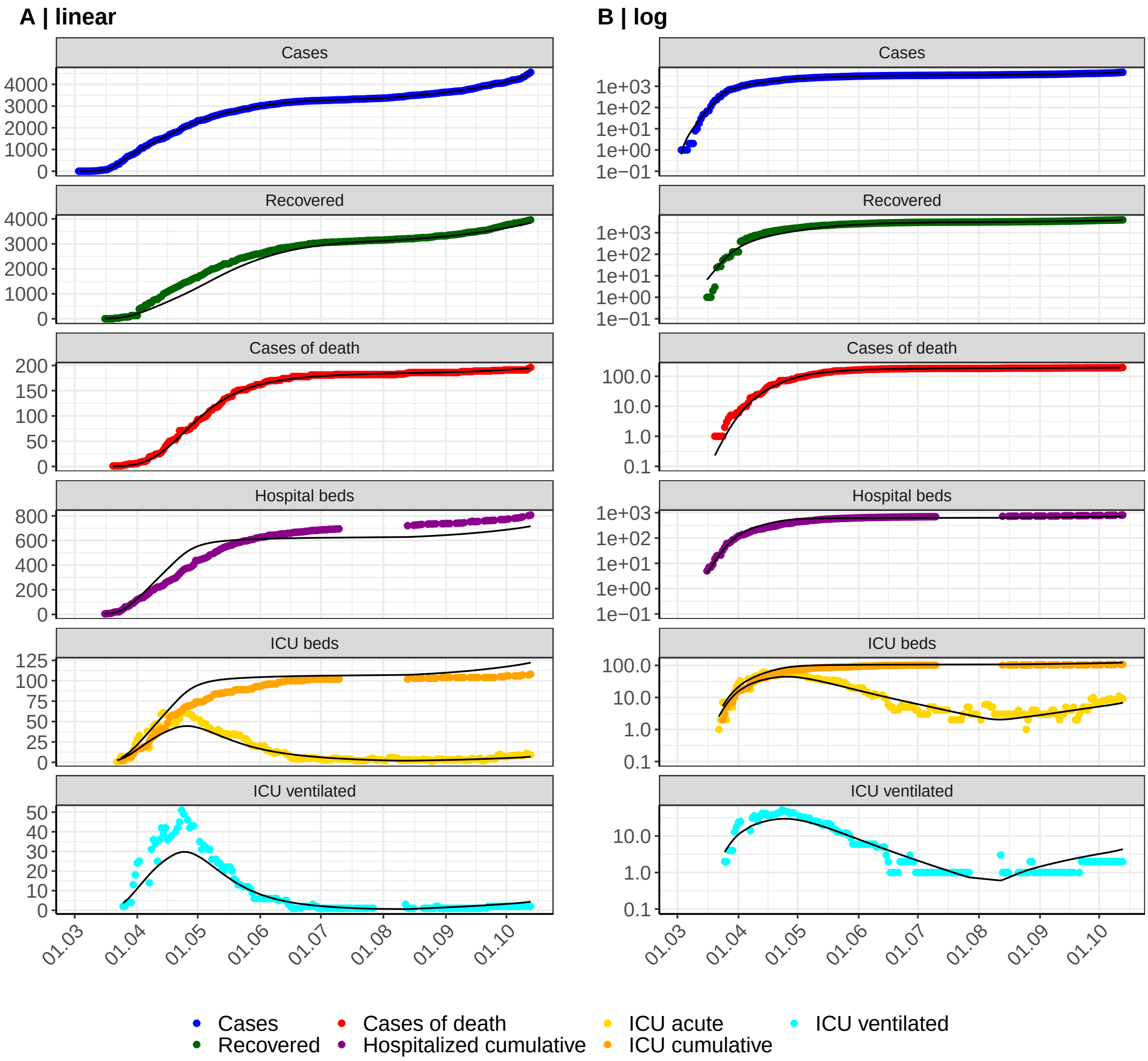



Figure 163: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Thuringia. Points: reported data; lines: model description.

Fig. 164 shows the goodness-of-fit for Thuringia. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

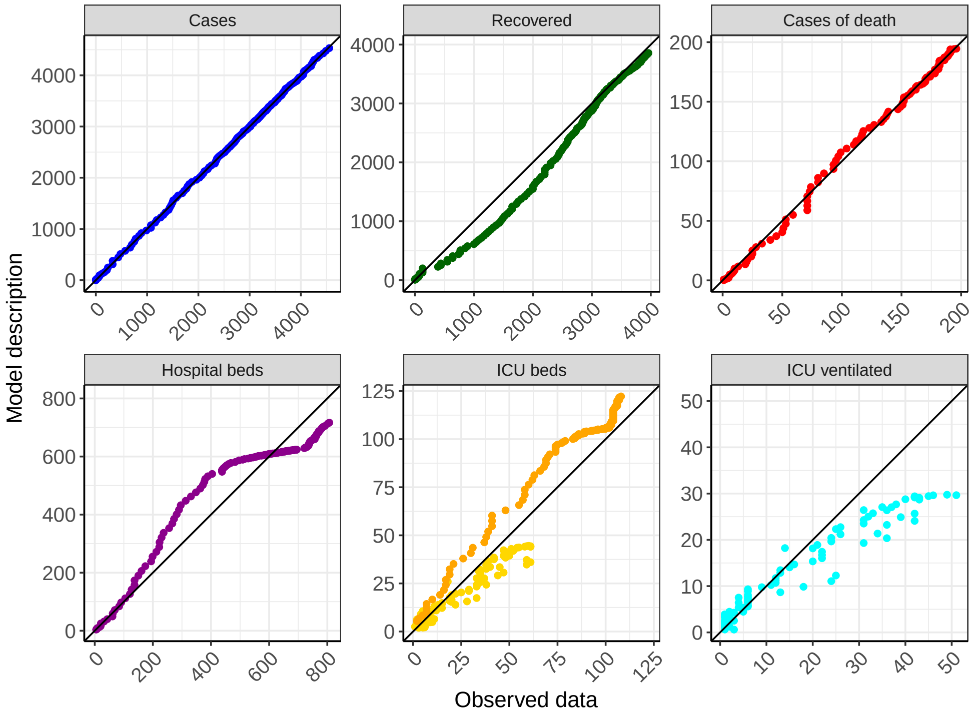



Figure 164: Goodness-of-fit plots for Thuringia. Lines: lines of identity.

Fig. 165 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Thuringia (red line) in comparison with the other federal states (grey lines).

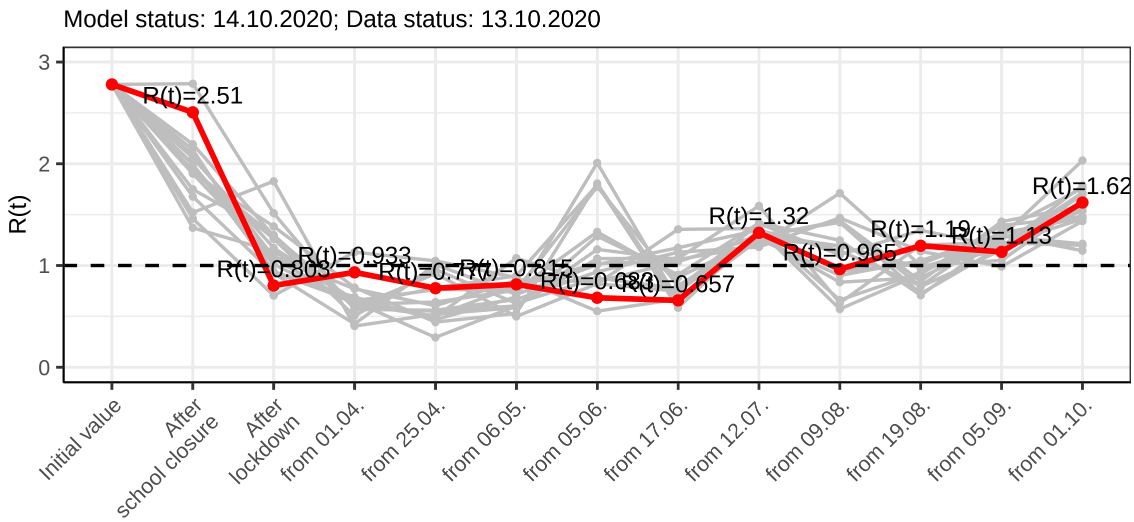



Figure 165: R(t) values before and after the NPIs for Thuringia

Fig. 166 shows the R(t) estimated value for Thuringia (red line) over time in comparison with the other federal states (grey lines).

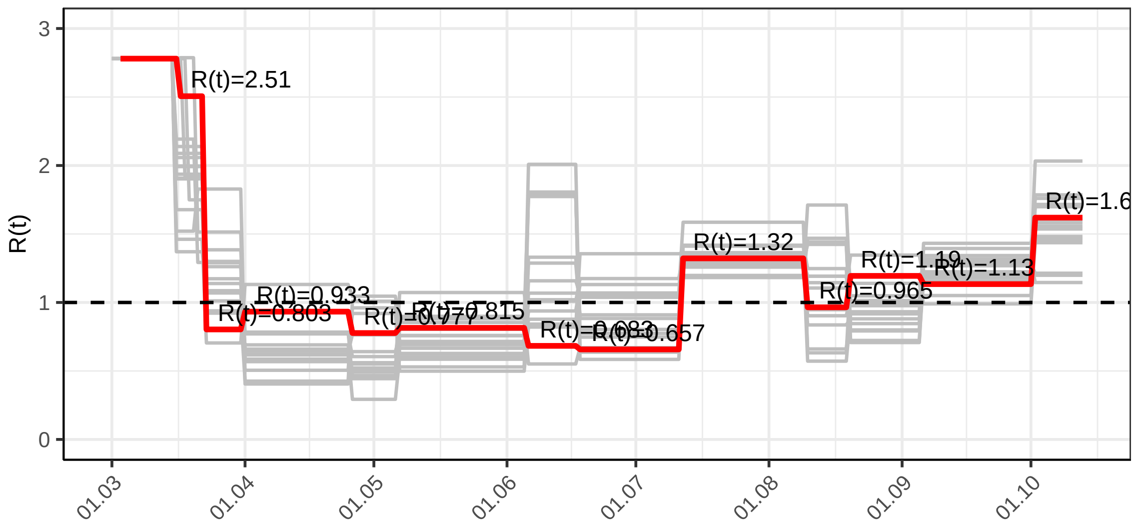



Figure 166: R(t) values over time for Thuringia

Fig. 167 shows the changes in hospitalization and death rates for Thuringia (red line) over time compared to the other states (grey lines).

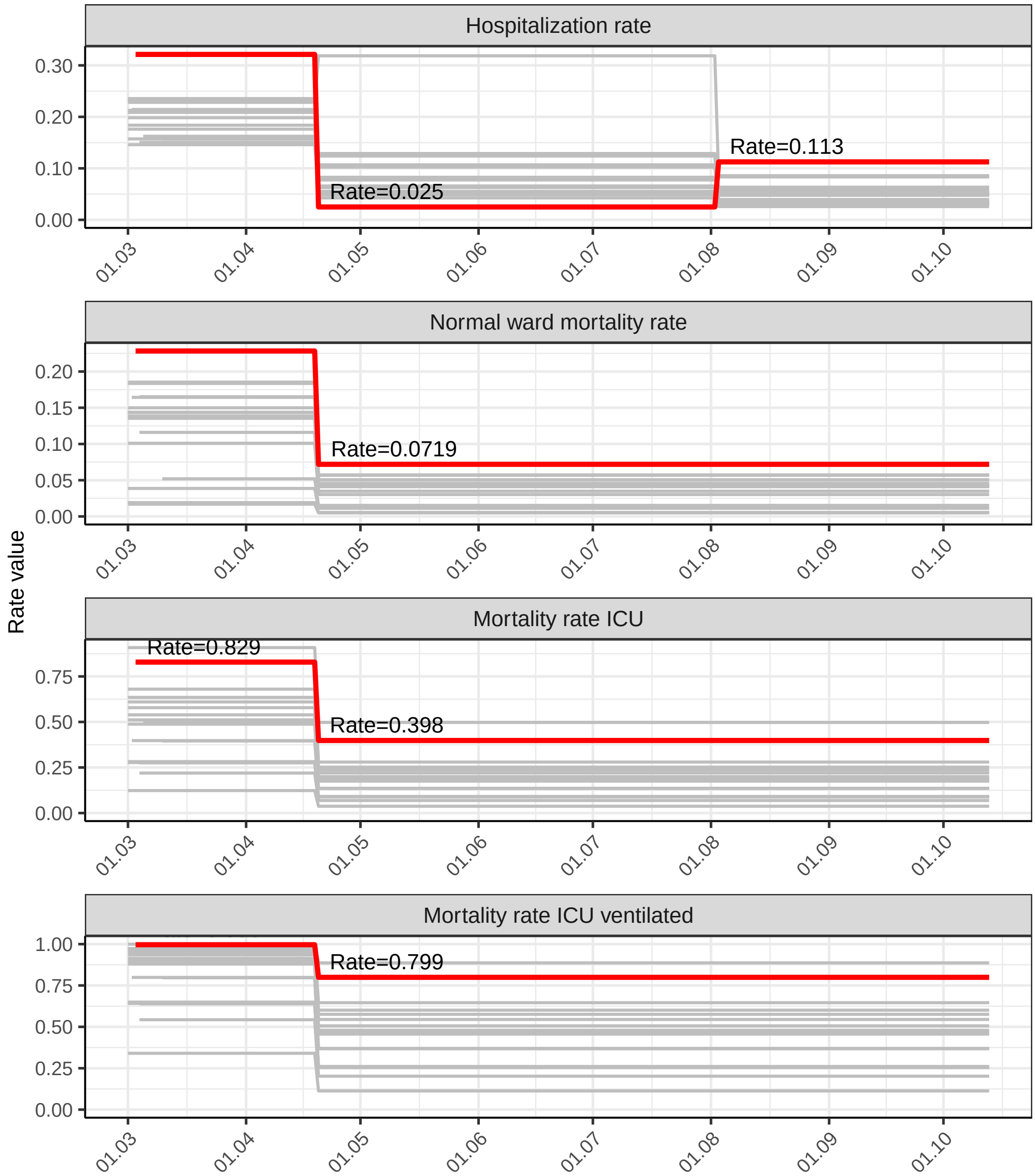



Figure 167: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Thuringia

## 17.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.62)

Fig.168 and 169 depict the the model predictions for the next 4 weeks for Thuringia on a linear (168) and a semi-logarithmic (169) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

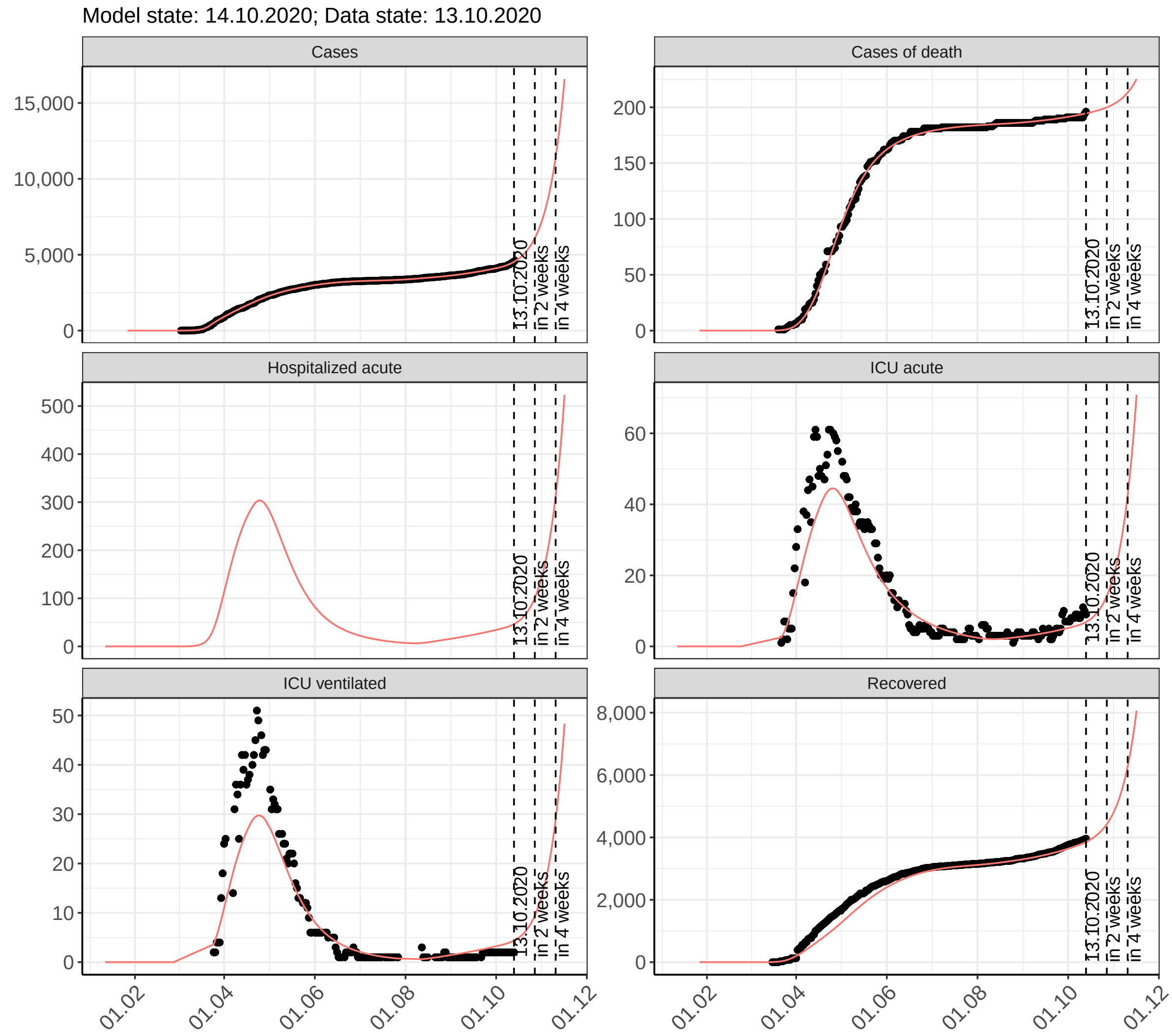



Figure 168: Representation of the model predictions for Thuringia for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

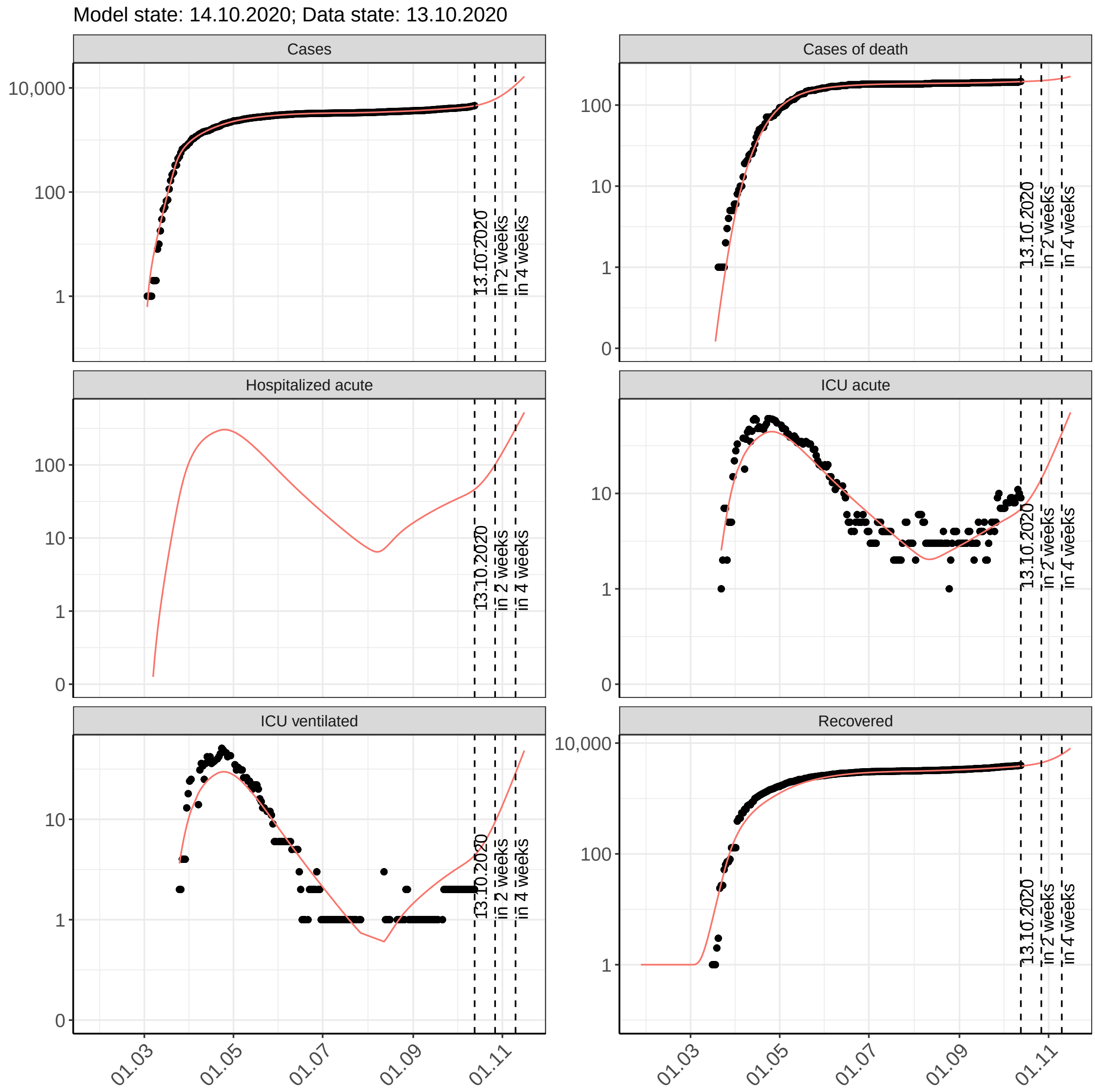



Figure 169: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Thuringia for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.170 and 171 represent the model prediction for the next 8 weeks for Thuringia on a linear (170) and a semi-logarithmic (171) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

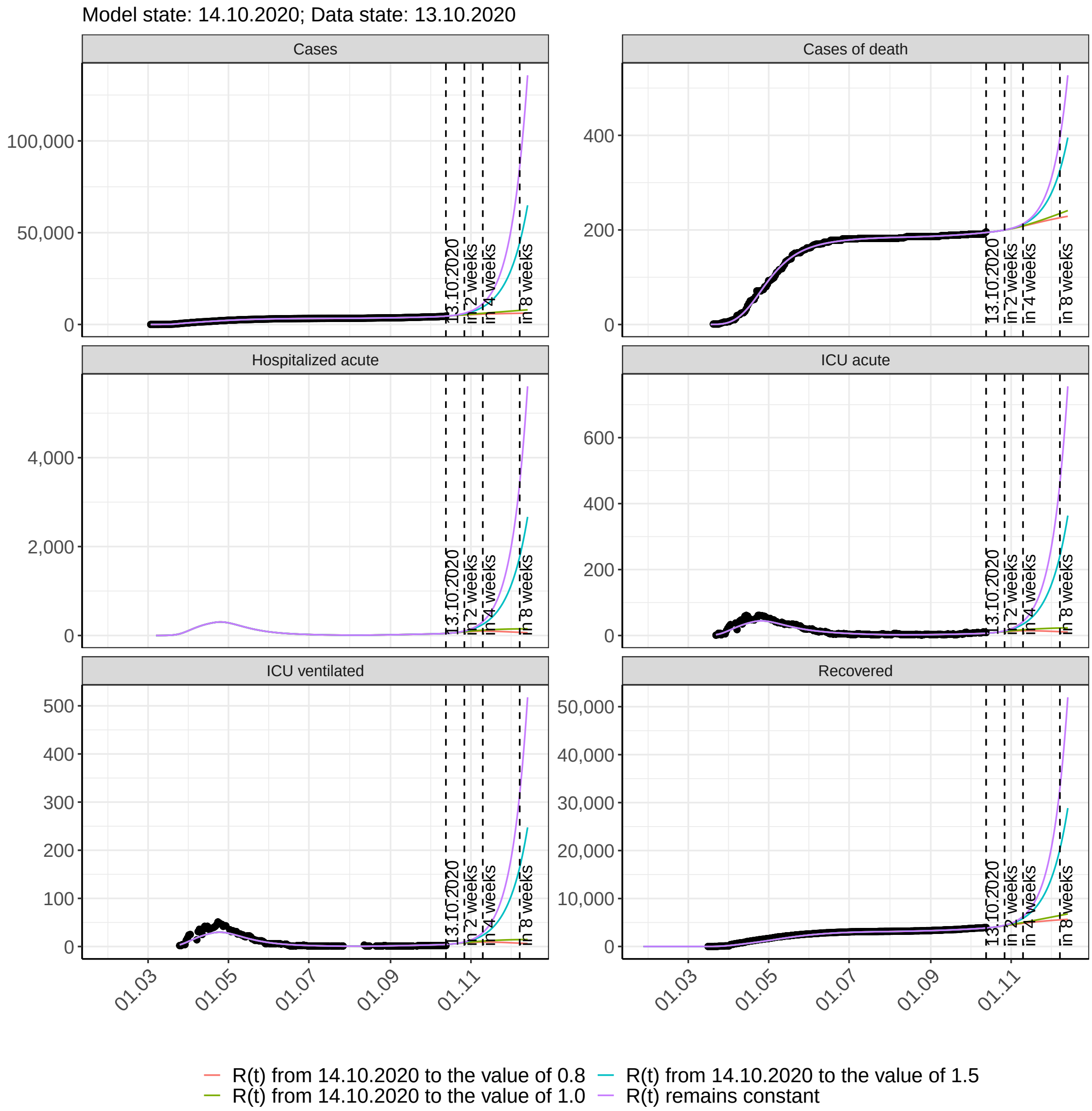



Figure 170: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Thuringia assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

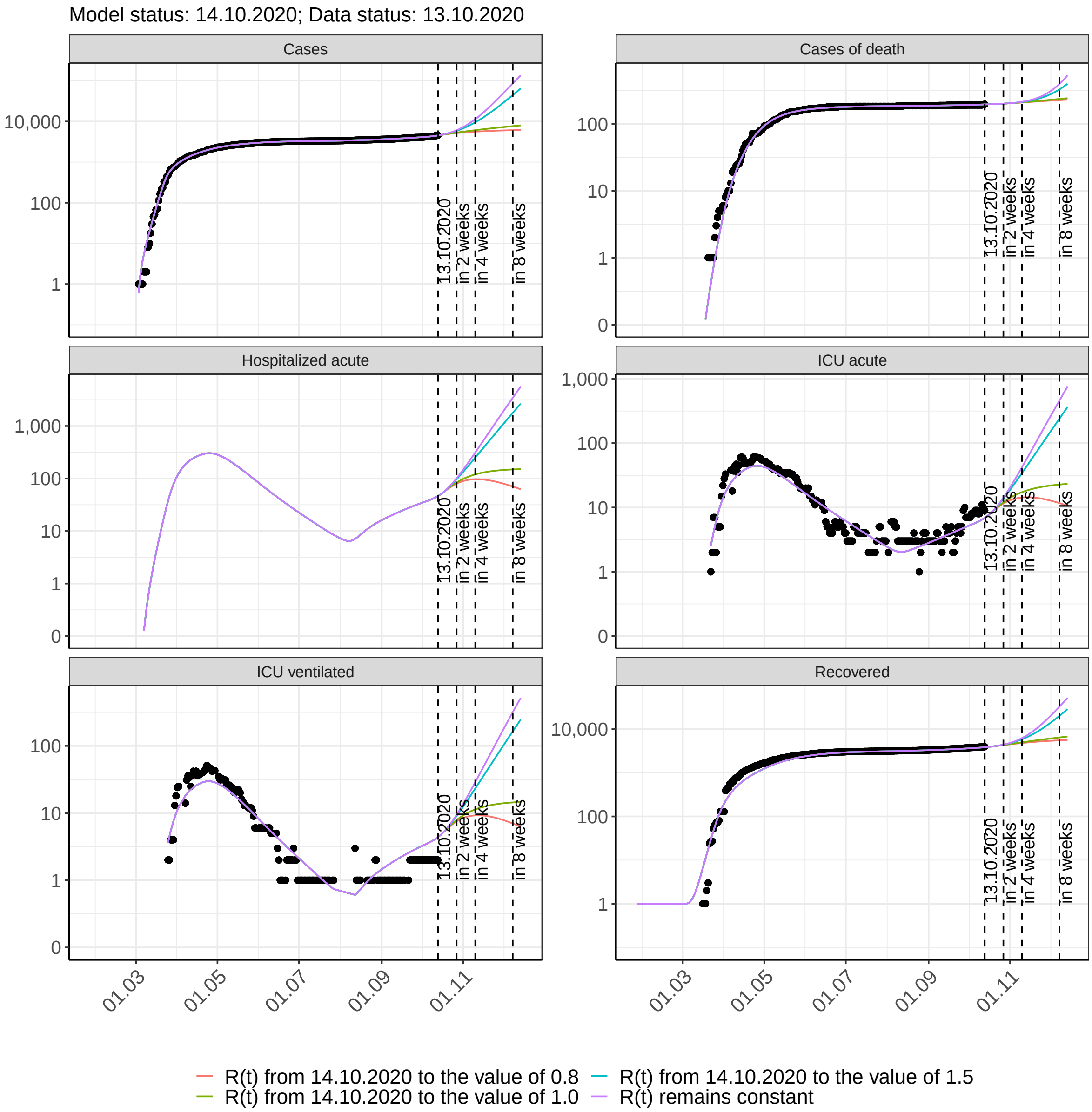



Figure 171: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Thuringia assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

### Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 172 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

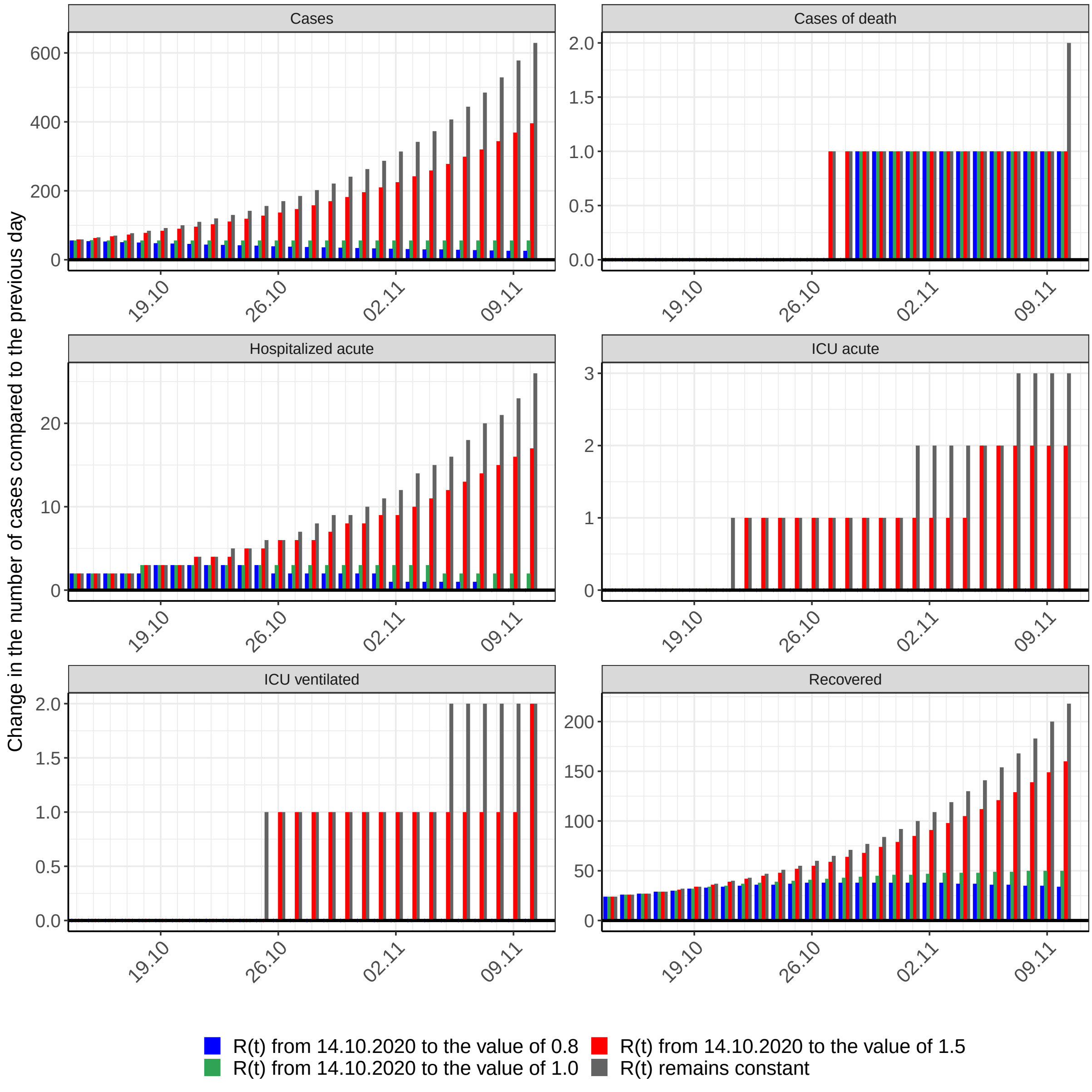



Figure 172: Simulation of daily new cases for the next 4 weeks - Thuringia

# 18 Germany

## 18.1 Model description

Fig. 173 depicts the results of the modeling (lines) compared to the observed data (points) for Germany on a linear (A) and semi-logarithmic (B) scale.

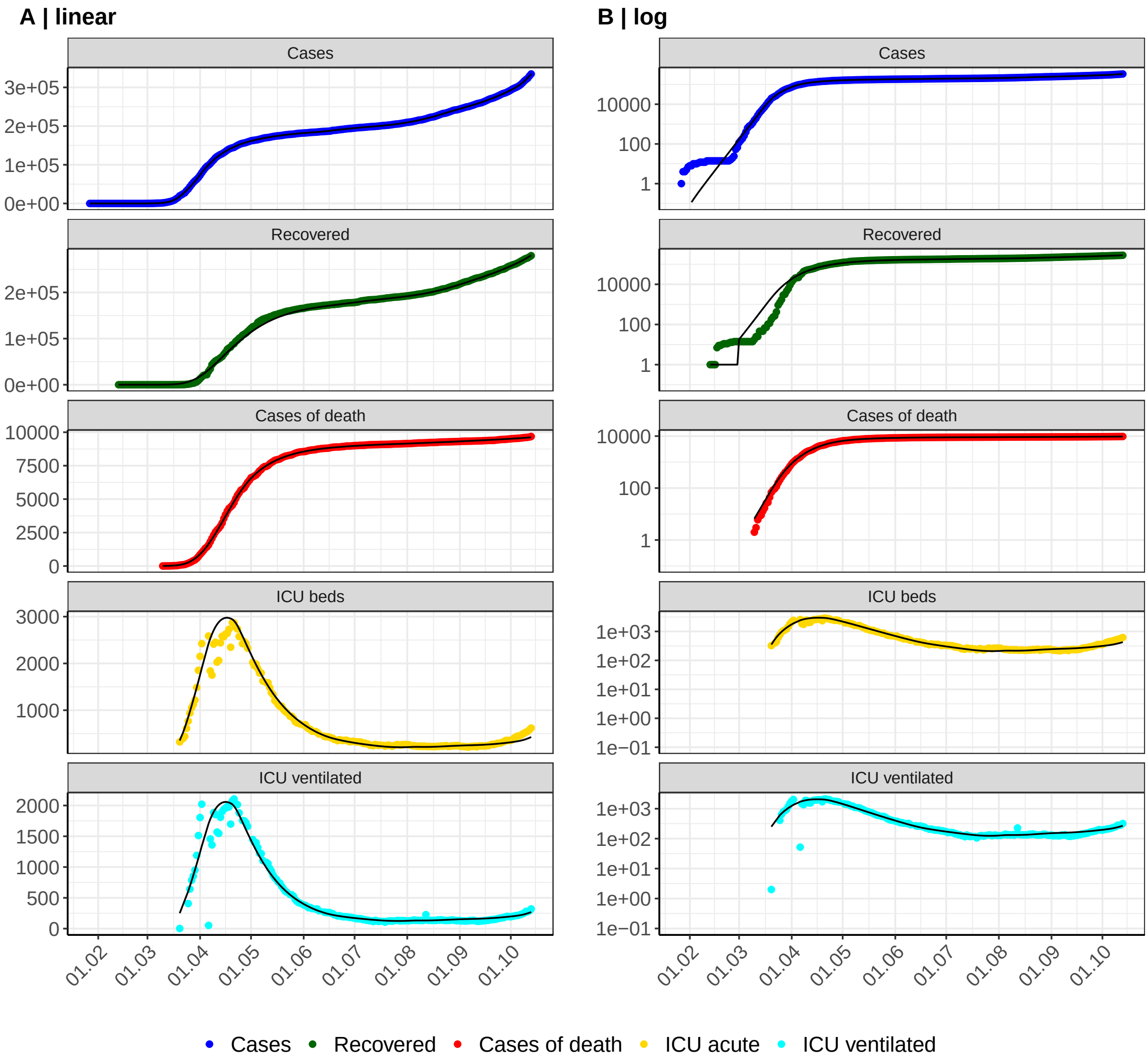



Figure 173: Model description of the reported case numbers, occupancy of hospital beds, recovery and deaths in Germany. Points: reported data; lines: model description.

Fig. 174 shows the goodness-of-fit for Germany. The values calculated by the model are plotted against the observed data. If the model fit is good, the points scatter randomly along the lines of identity.

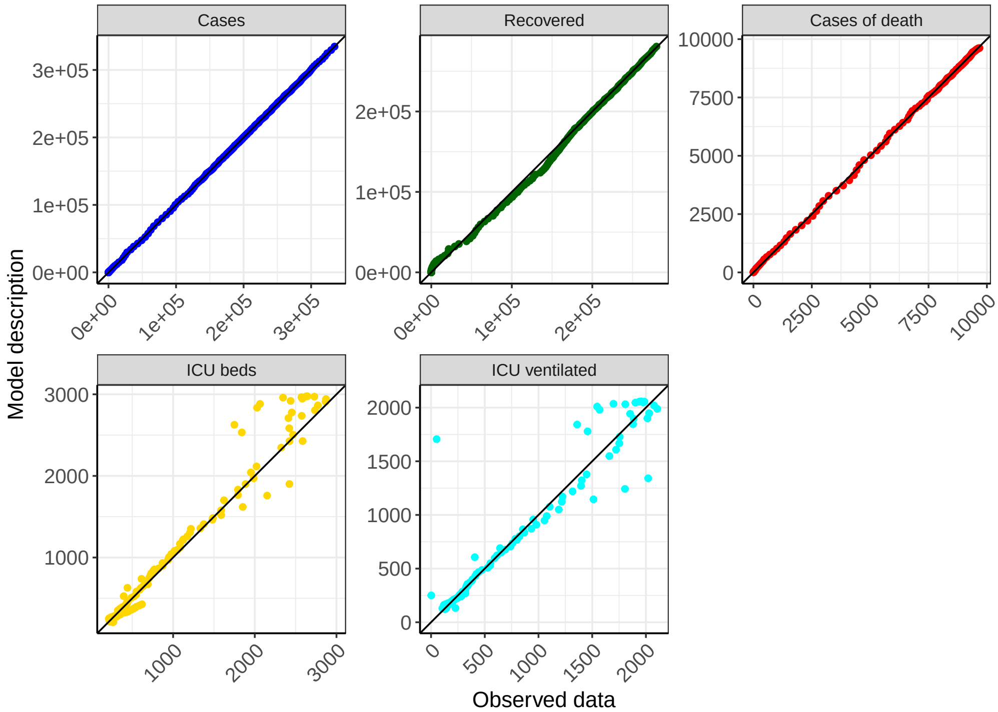



Figure 174: Goodness-of-fit plots for Germany. Lines: lines of identity.

Fig. 175 shows the influence of non-pharmaceutical interventions (NPI) on R(t) for Germany (red line) in comparison with the other federal states (grey lines).

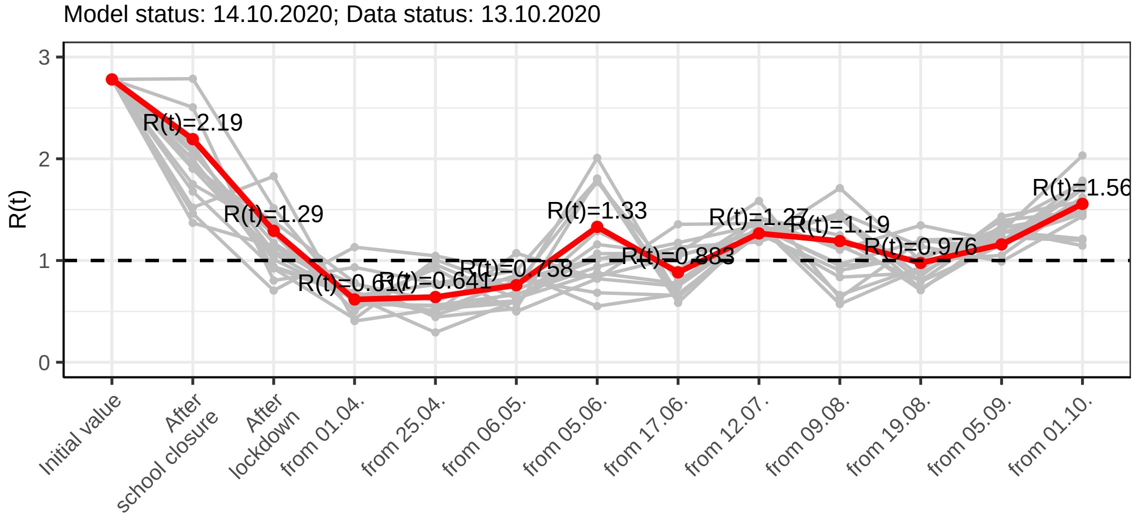



Figure 175: R(t) values before and after the NPIs for Germany

Fig. 176 shows the R(t) estimated value for Germany (red line) over time in comparison with the other federal states (grey lines).

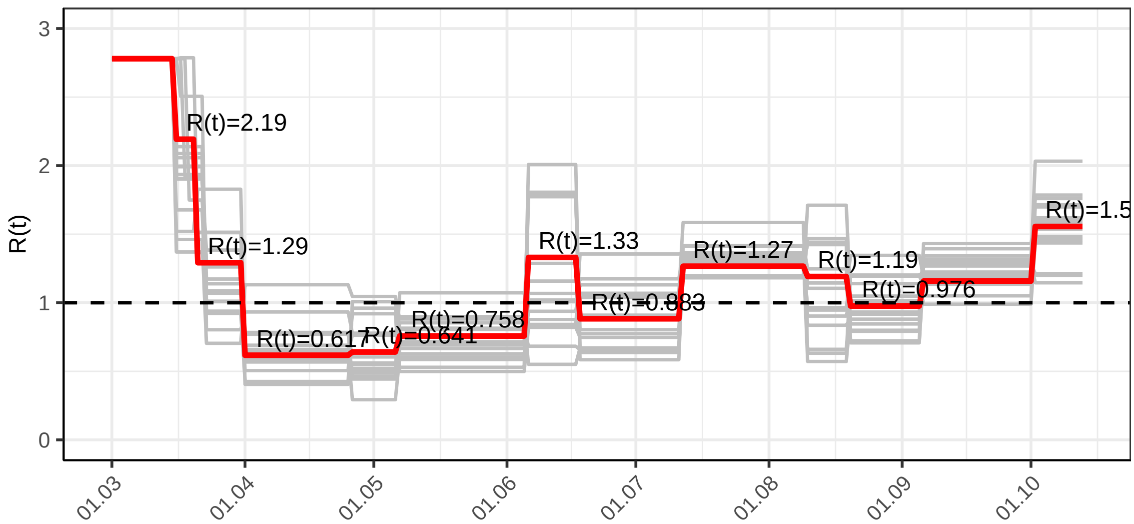



Figure 176: R(t) values over time for Germany

Fig. 177 shows the changes in hospitalization and death rates for Germany (red line) over time compared to the other states (grey lines).

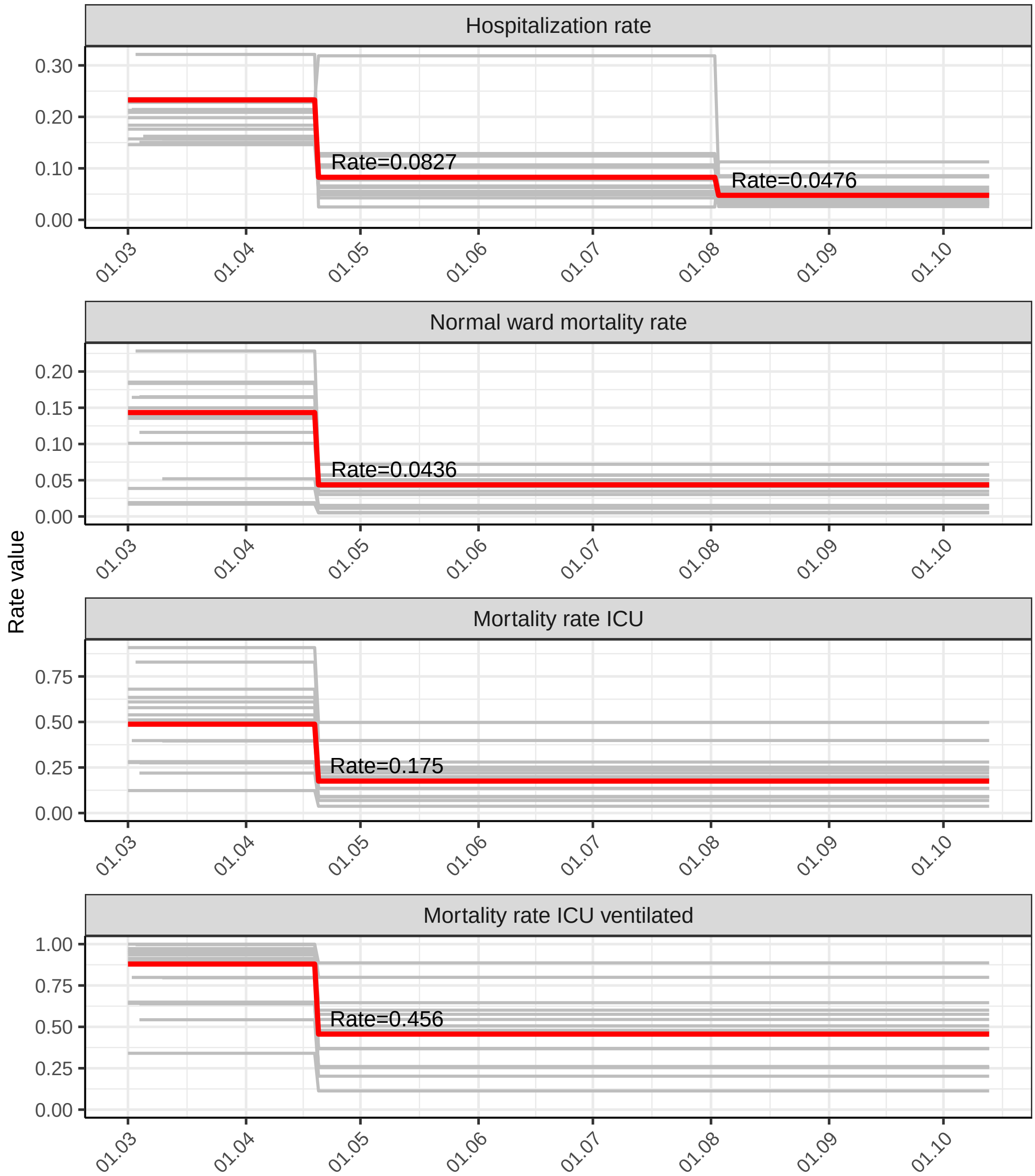



Figure 177: Hospitalization rate and death rates (normal ward, ICU and ICU ventilated) over time for Germany

## 18.2 Model predictions

### Prediction for the next 4 weeks assuming that R(t) estimate will not change (R(t) = 1.56)

Fig.178 and 179 depict the the model predictions for the next 4 weeks for Germany on a linear (178) and a semi-logarithmic (179) scale. The modeling was carried out under the assumption that the R(t) estimated value would remain the same.

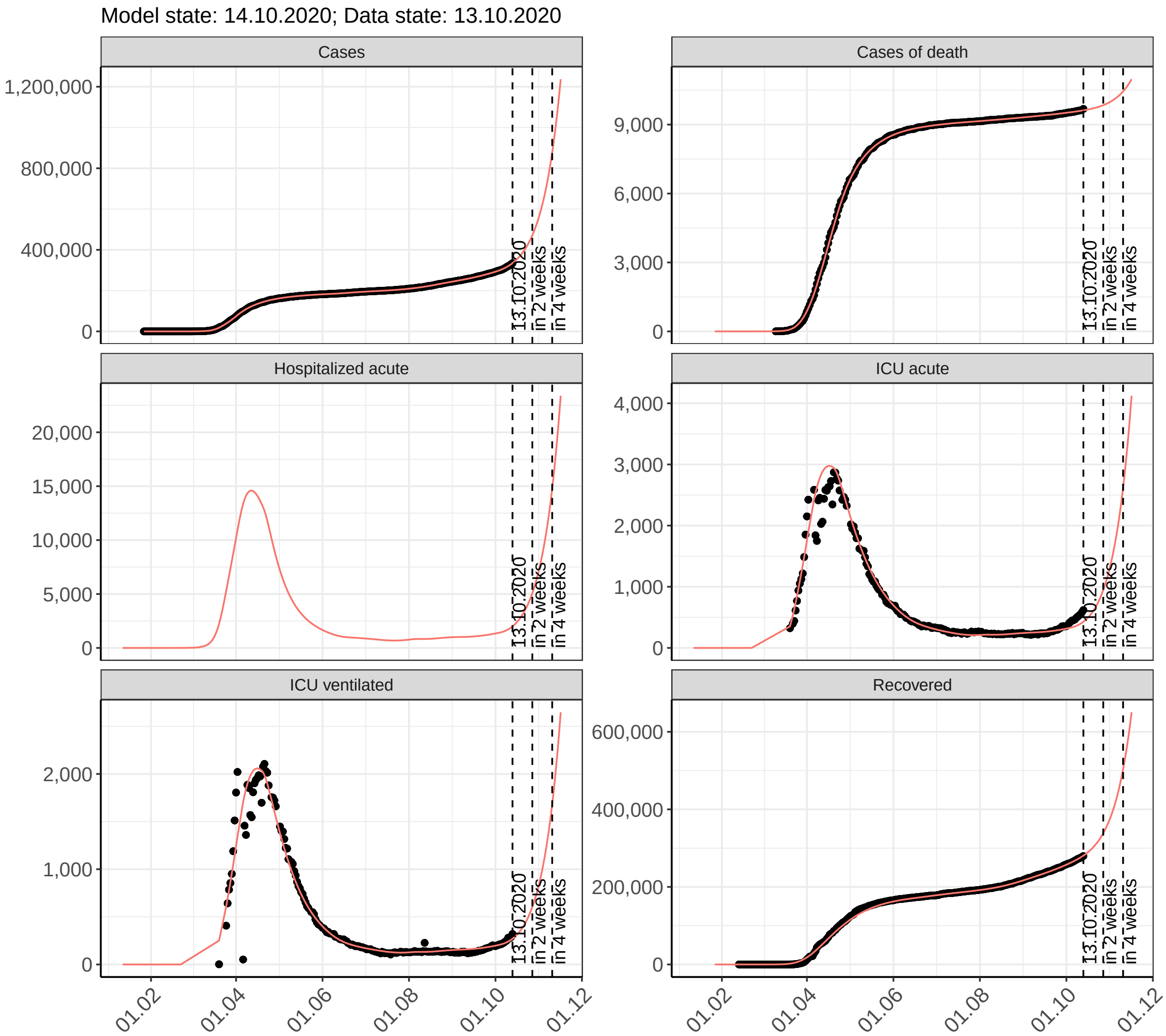



Figure 178: Representation of the model predictions for Germany for the next 4 weeks under the assumption that the R(t) estimate remains the same on linear scale (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths). Points: Reported case numbers; Red lines: Model predictions.

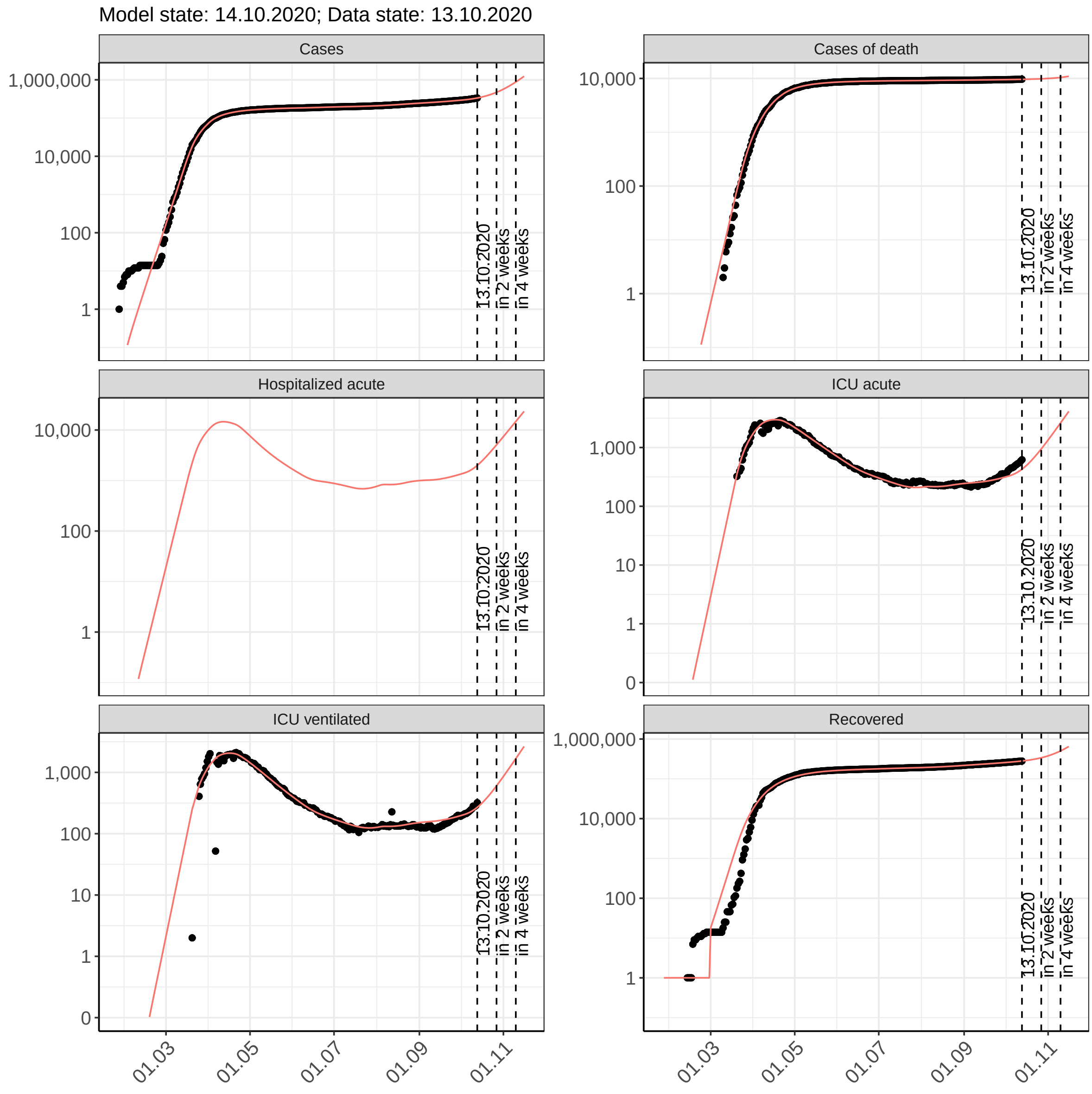



Figure 179: Semi-logarithmic representation of the model prediction (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Germany for the next 4 weeks under the assumption that the R(t) estimate remains the same. Points: Reported case numbers; Red lines: Model predictions.

### Prediction for the next 8 weeks assuming various scenarios from 14.10.2020

Fig.180 and 181 represent the model prediction for the next 8 weeks for Germany on a linear (180) and a semi-logarithmic (181) scale. In this simulation different scenarios of the possible course from the 14.10.2020 were tested.

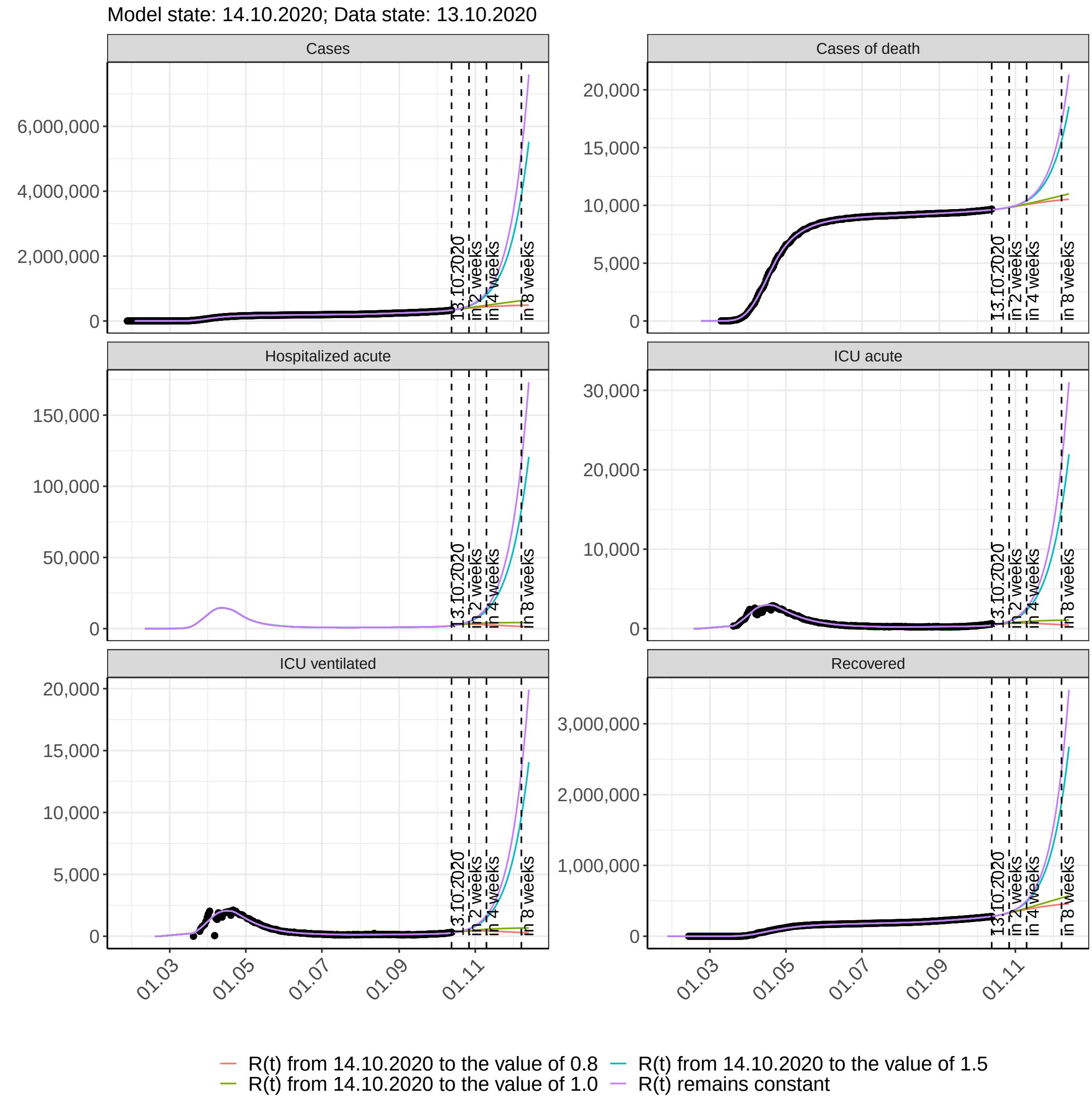



Figure 180: Linear representation of model predictions (case numbers, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Germany assuming various scenarios from the 14.10.2020. Points: reported case numbers; lines: model prediction.

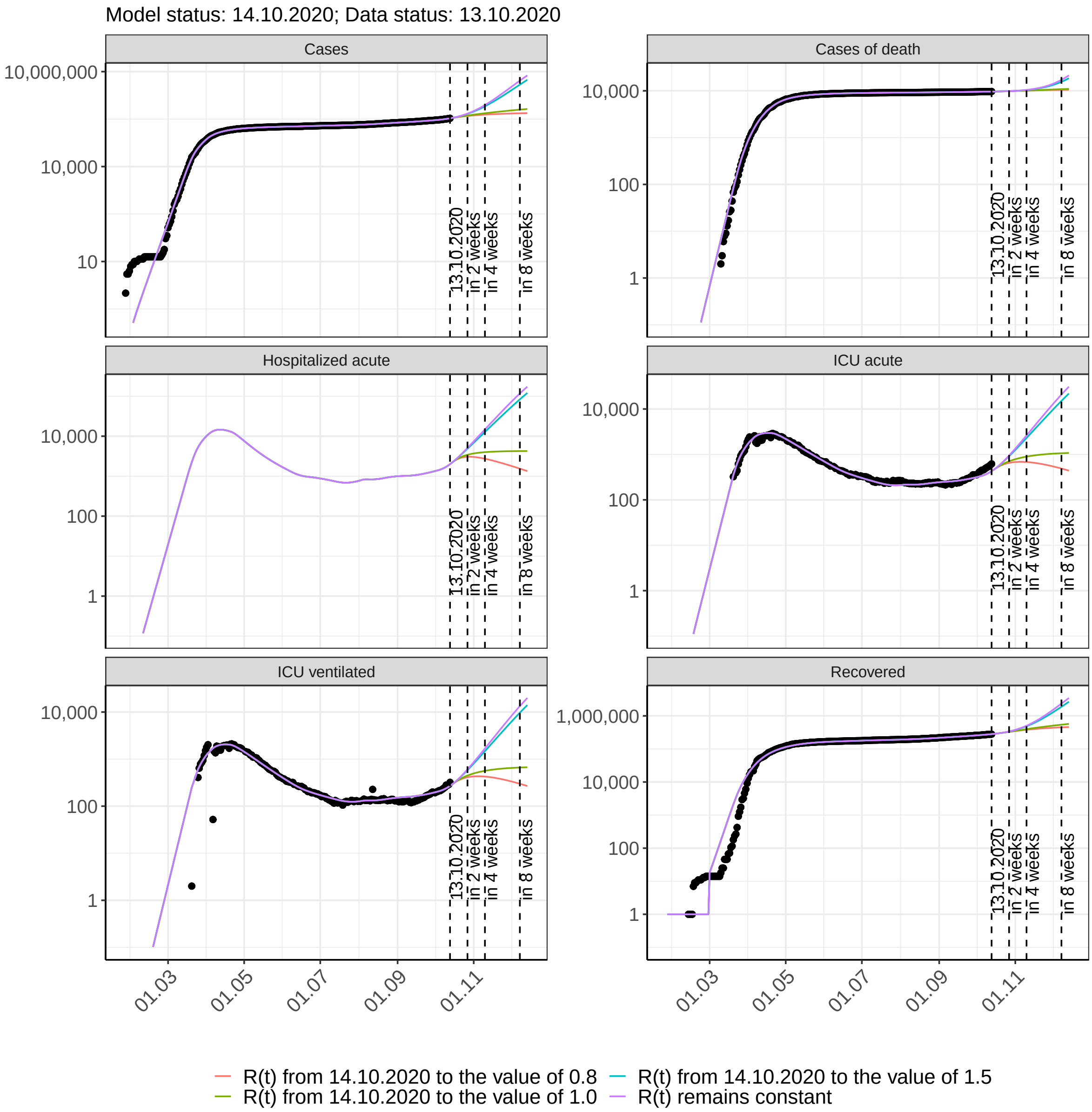



Figure 181: Semi-logarithmic depiction of the model prediction (cases, recovered, ICU ventilated, ICU beds, hospital beds, deaths) for Germany assuming various scenarios after 14.10.2020. Points: reported case numbers; lines: model predictions.

## Prediction for the next 4 weeks under the assumption of different scenarios from 14.10.2020

Fig. 182 shows the absolute changes in case numbers compared to the previous day for the next 4 weeks for different R(t) values. If no bars are shown on the plot it means that the number of cases has not changed compared to the previous day.

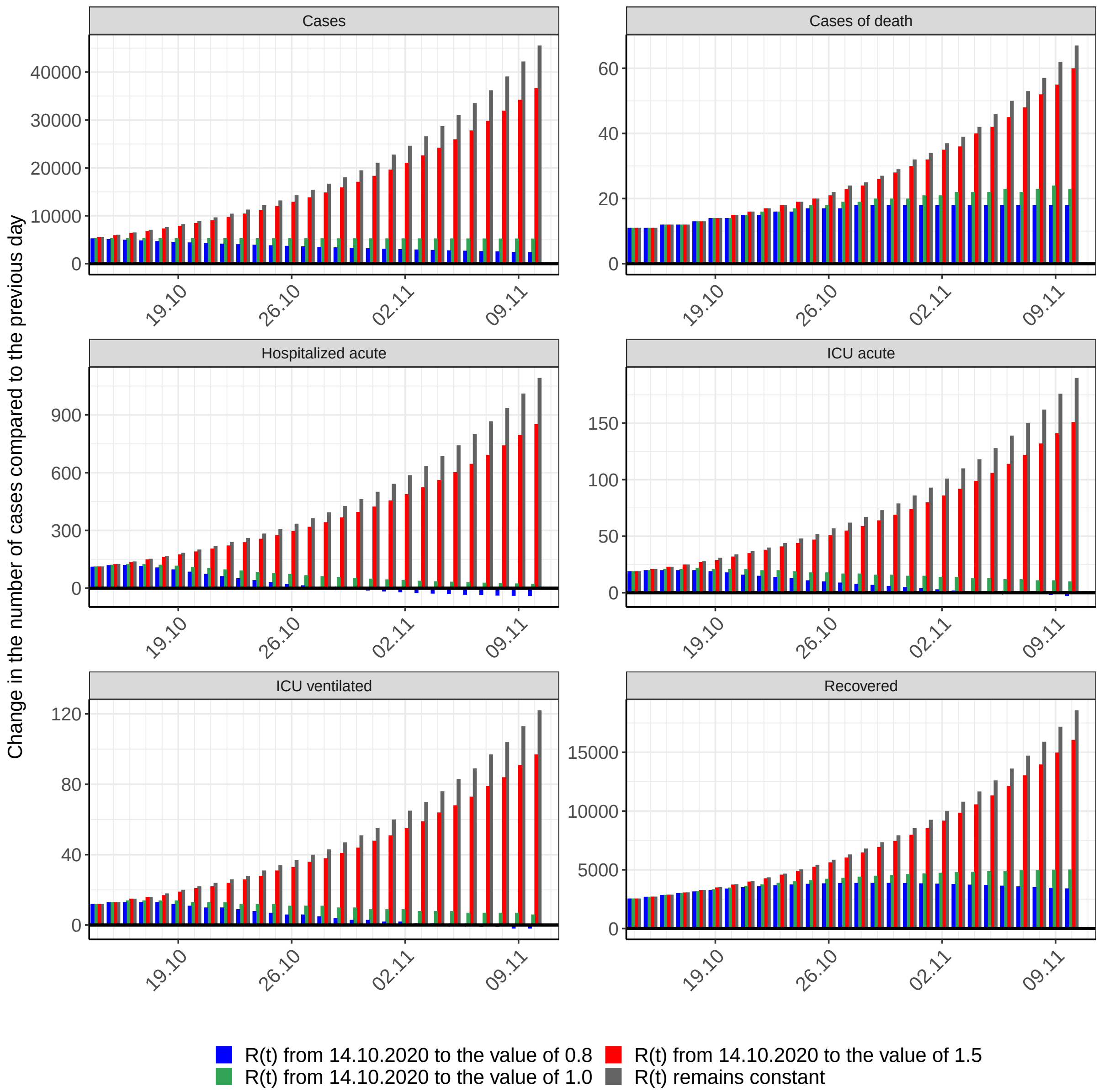



Figure 182: Simulation of daily new cases for the next 4 weeks - Germany