Modeling numbers of infected and deceased - Adjustment by test volume

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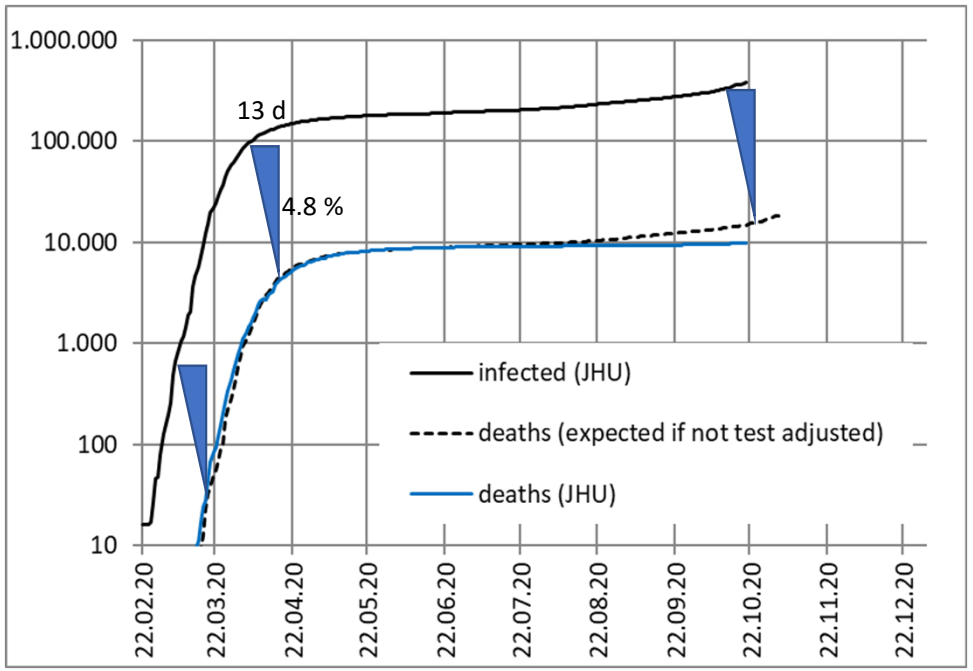
Results

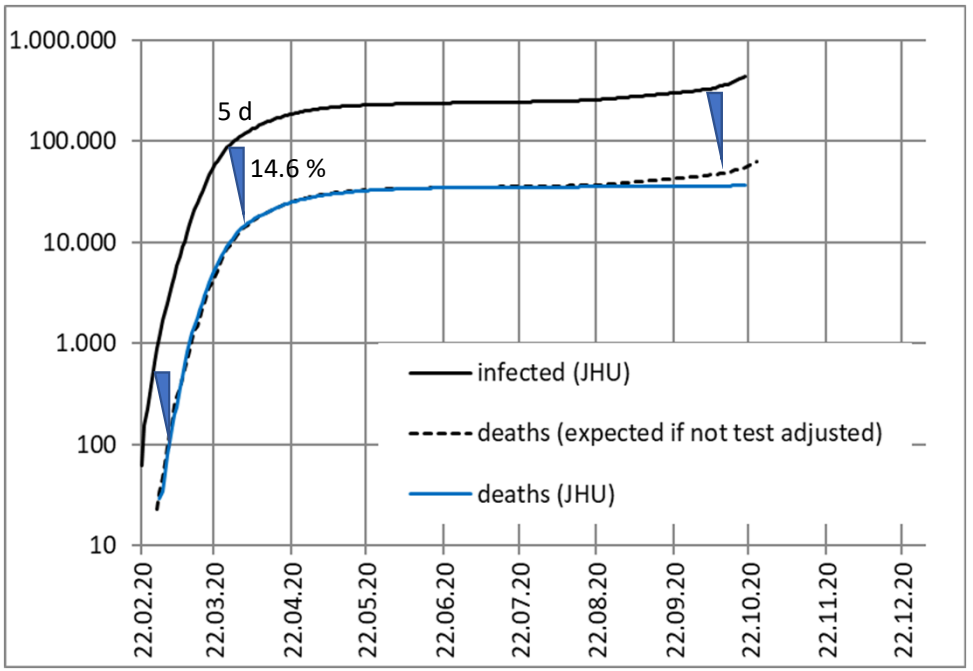
- We observed a strong connection between infections and deaths numbers in 1st wave
- We found a simple sufficient model for 1st and 2nd wave and the interim time
- Only test adjusted infection numbers serve for riskiness and deaths prediction

6th Debate COVID-19 Forecast and Prediction, October 23rd-24th, 2020, by Karolinska Institute, Stockholm

During 1st wave, numbers of deaths followed number of infected (confirmed cases).



Accumulated data in **Germany**, logarithmic scale

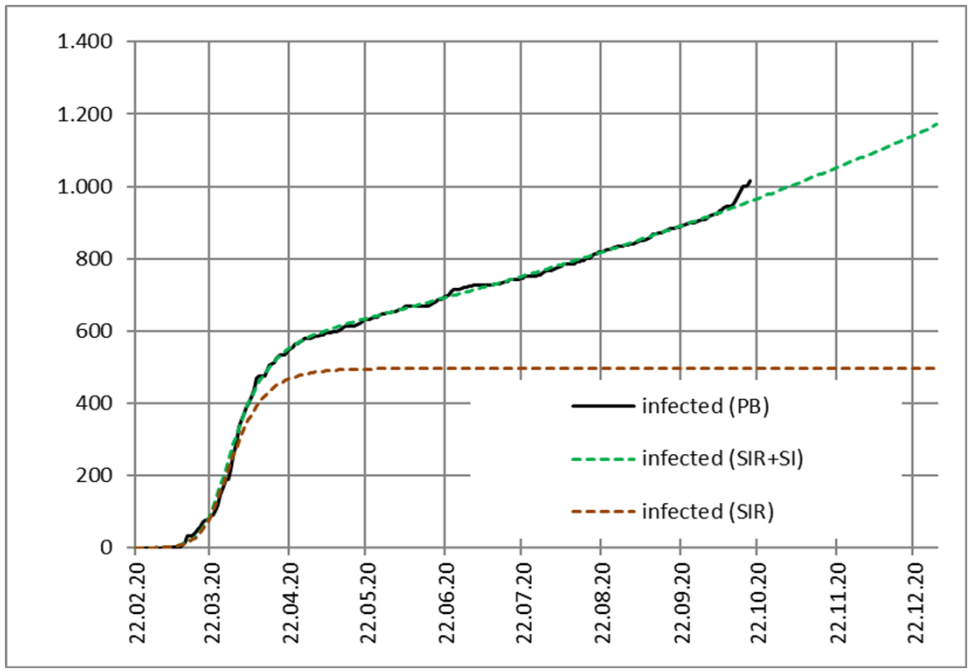


Accumulated data in **Italy**, logarithmic scale

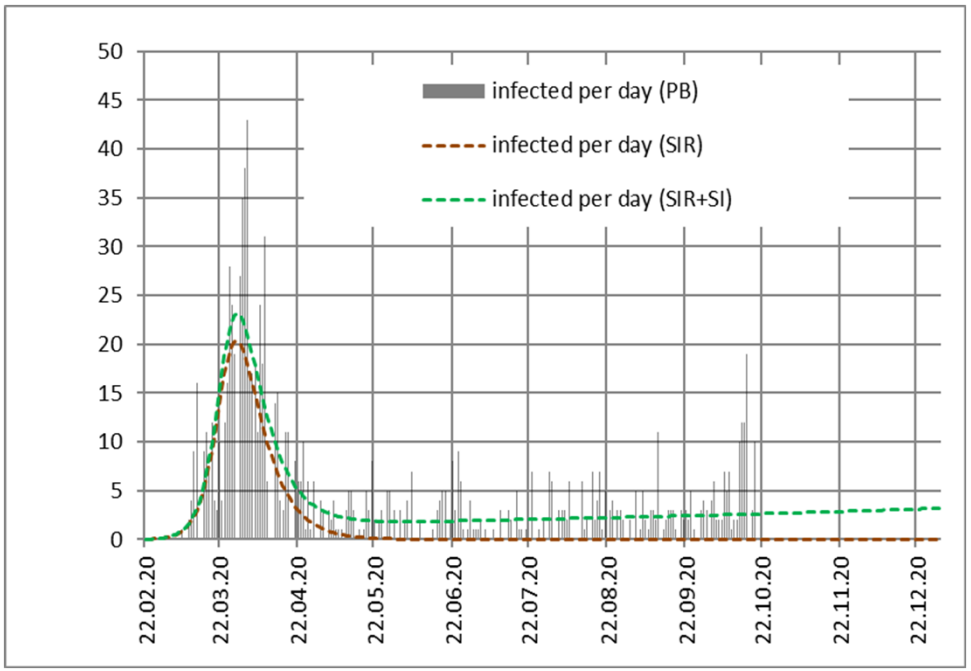
- Germany: 4.8 % of the total number of infected persons have died 13 days after confirmation during 1st wave
- Dependence is valid for many countries, but with different delays and percentages
- Published in Medrxiv in August, 11 ("On the numbers of infected and deceased in the second Corona wave")
- After June, deviations began and led us to model the data

Data from John-Hopkins-University (JHU)

Only one wave in district Paderborn, Germany, until shortly. A good base for modeling.



Accumulated infected for district Paderborn (300.000 inhabitants)

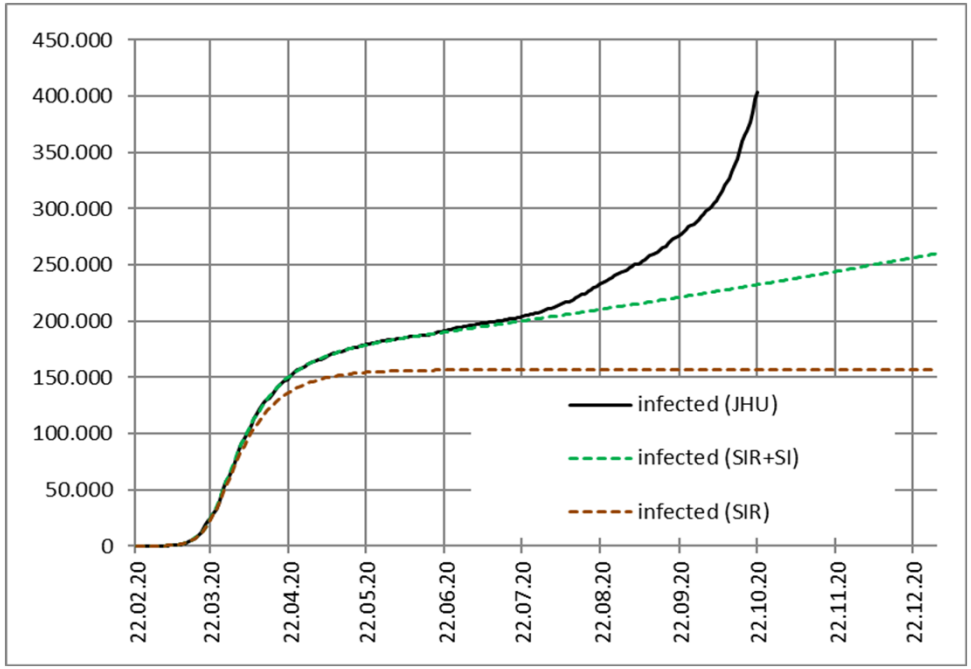


Daily infected for district Paderborn

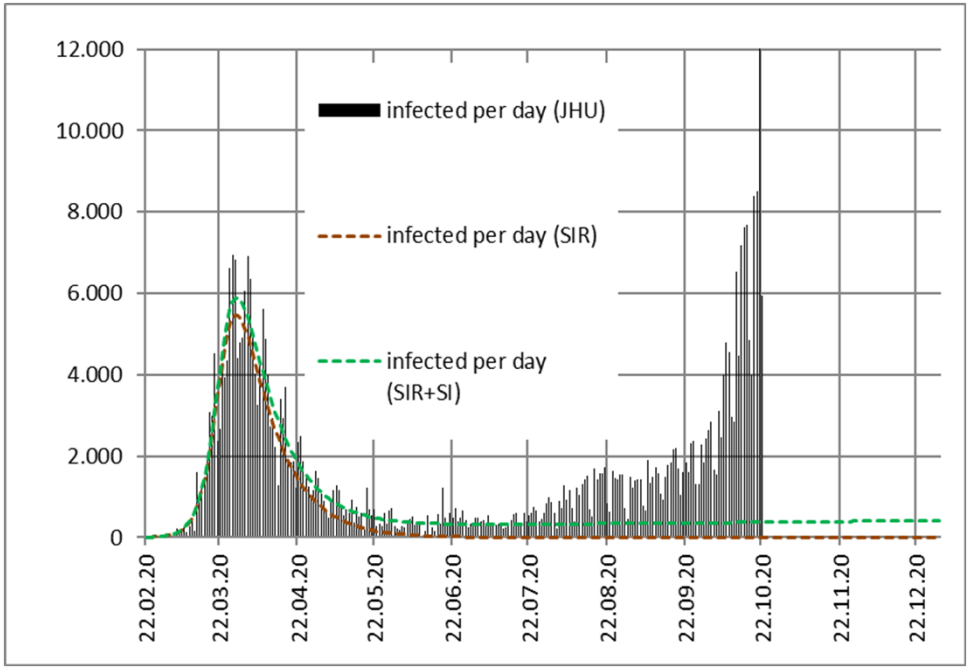
- First wave did not end in June, in contrast to prediction by a SIR model applied to contact restriction.
- The continuous exponential growth since June is small, as masks and distance keeping were principally observed.
- Combination of SIR model with an SI model shows a good compliance with real data above.

Data from local health department (PB)

Data for Germany show apparently a big 2nd wave since July



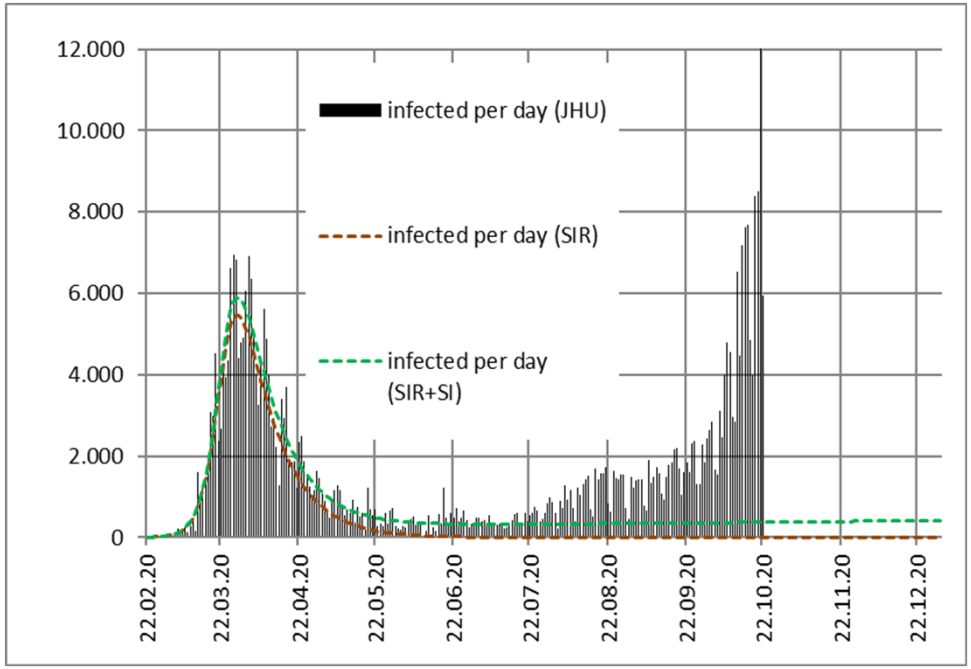
Accumulated infected in Germany



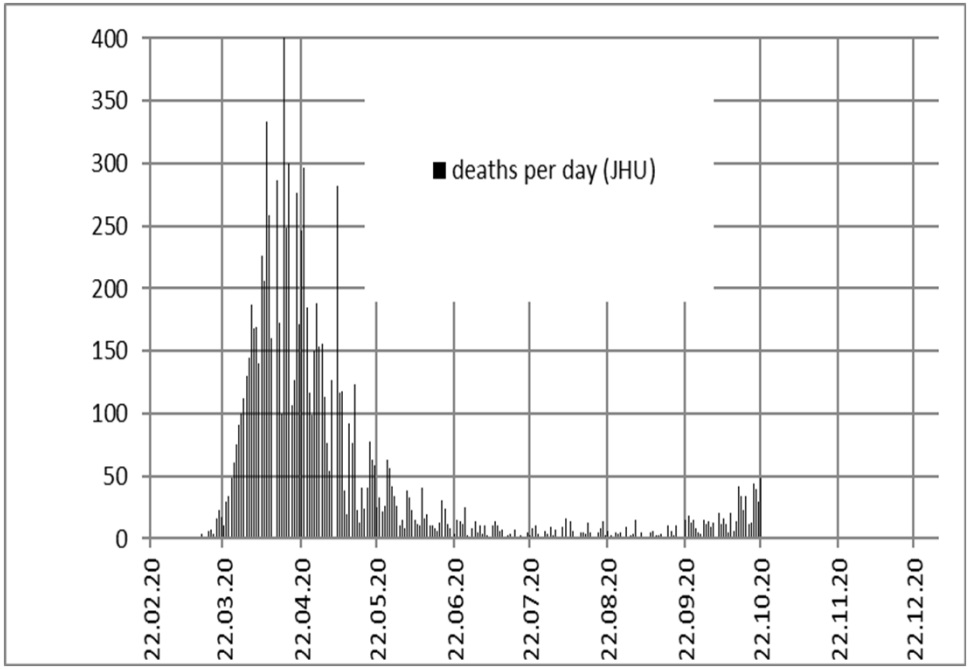
Daily infected in Germany

- Since July, infection course deviates heavily from SIR+SI model.

Germany since July: infection data rising, but deaths data remaining low



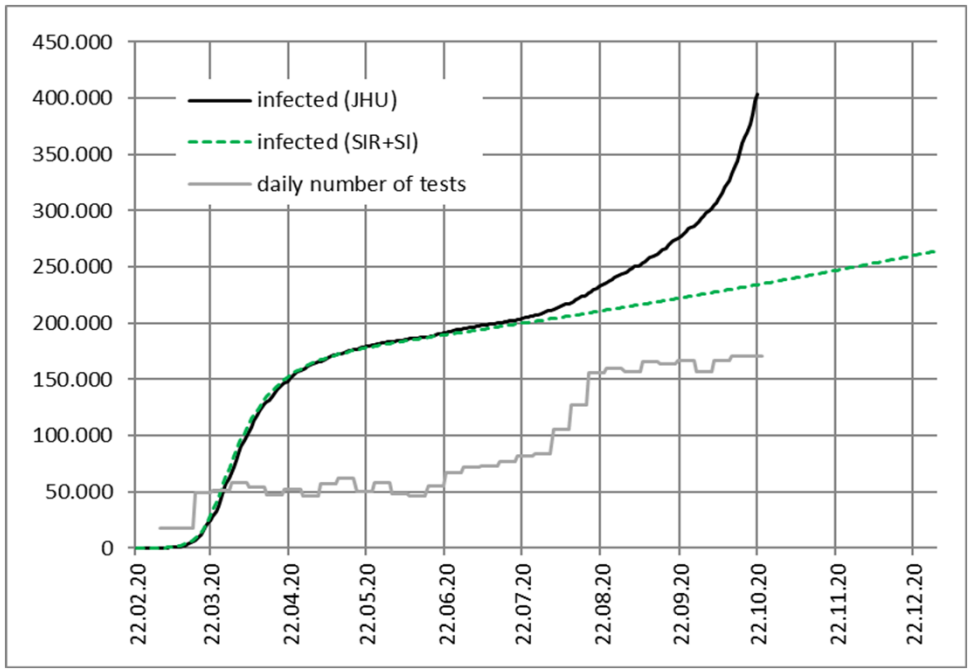
Daily infected in Germany



Daily deaths in Germany

- Only since October, a much lower 2nd wave in deaths appears so far in Germany.
- This is also true in many European countries like Italy, France, Great Britain, Netherlands etc.

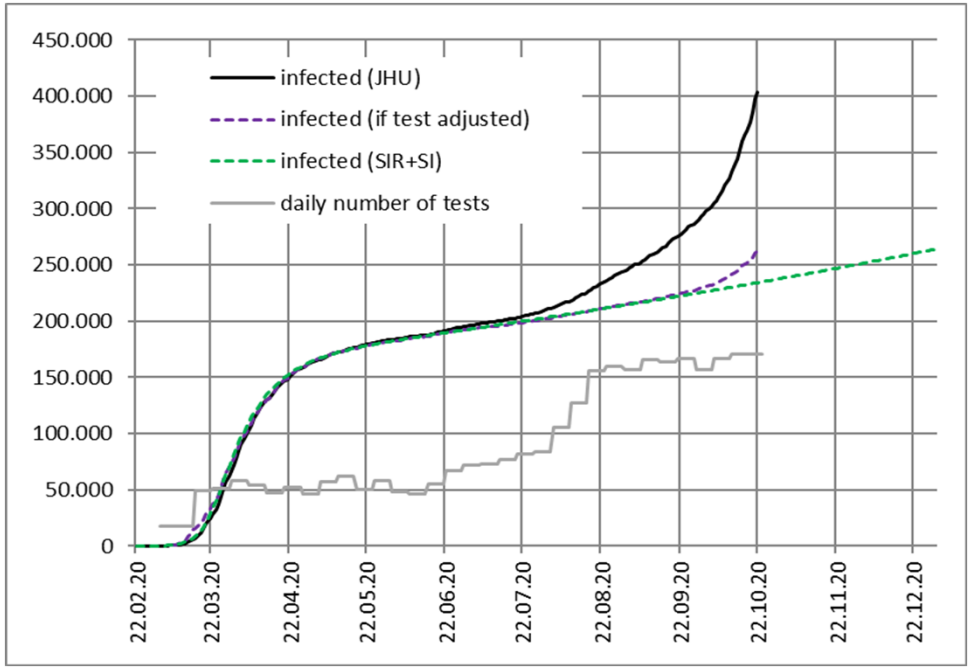
Test volume has tripled in Germany since June, coinciding with rising confirmed infections



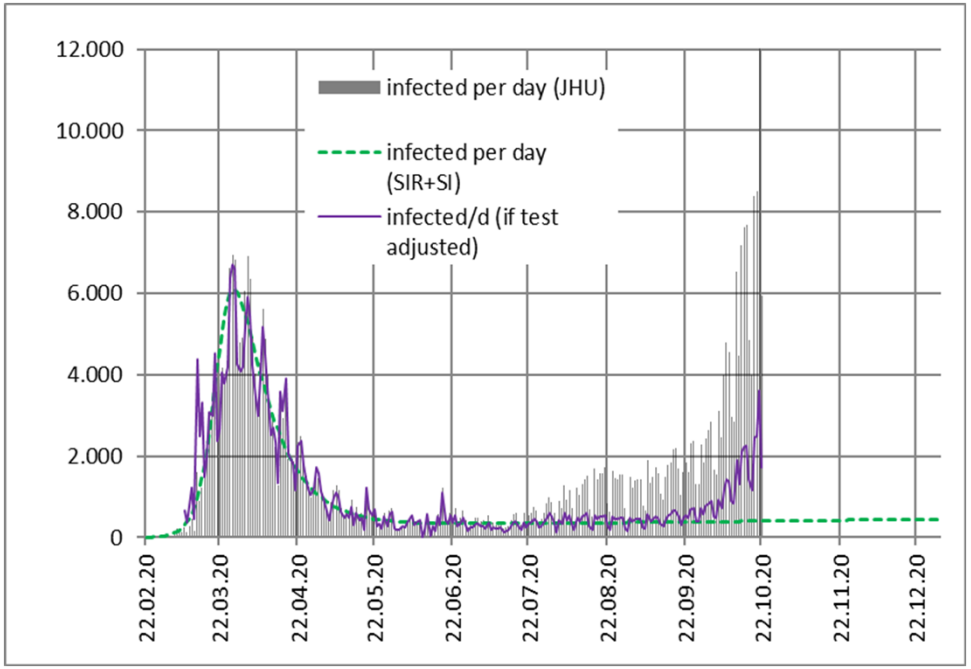
Infected and daily test volume in Germany

- **Daily test volume** has increased from about 50.000 tests per day during 1st wave until 170.000 in October
- **Test volume** coincides with rising infection data since June

Dividing infection numbers by numbers of tests gives more realistic Covid-19 state



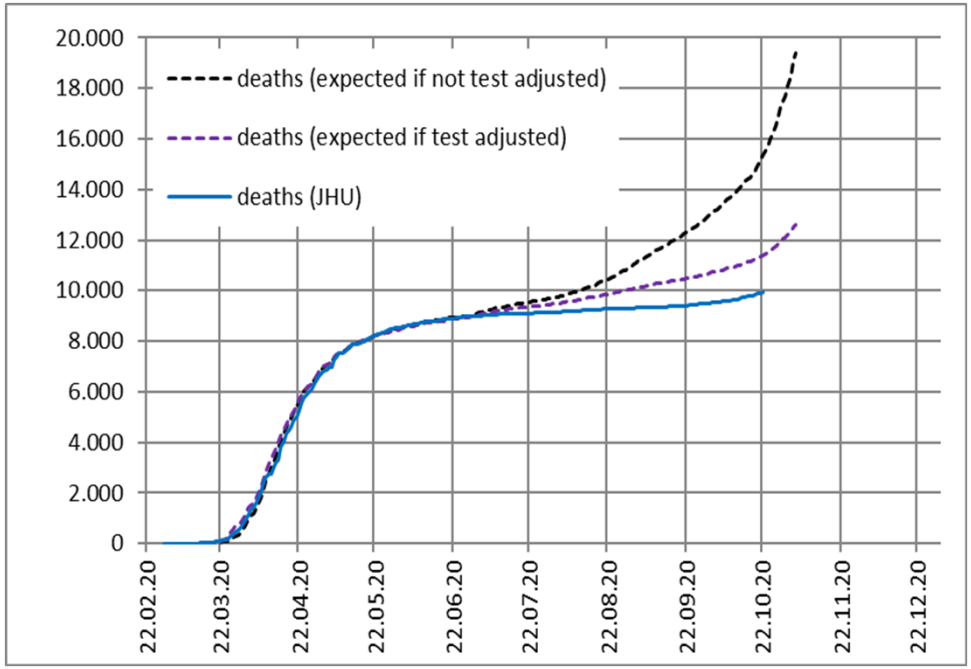
Accumulated infected and daily test numbers in Germany



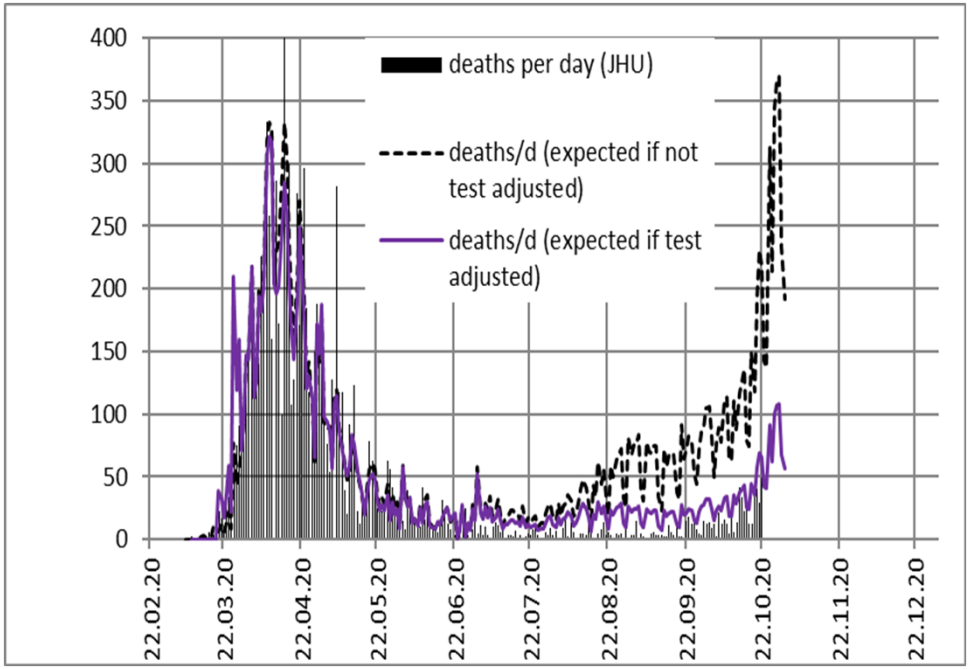
Daily infected in Germany

- We divided the **daily infection number** by the **daily test number** (equivalent to the positive rates), and scaled them to the 1st wave.
- This **test adjusted infection number** follows the **SIR+SI model** from start in February until October.
- A 2nd wave has started only since October.

During 1st and 2nd waves, numbers of deaths follow the number of test adjusted infected in Germany



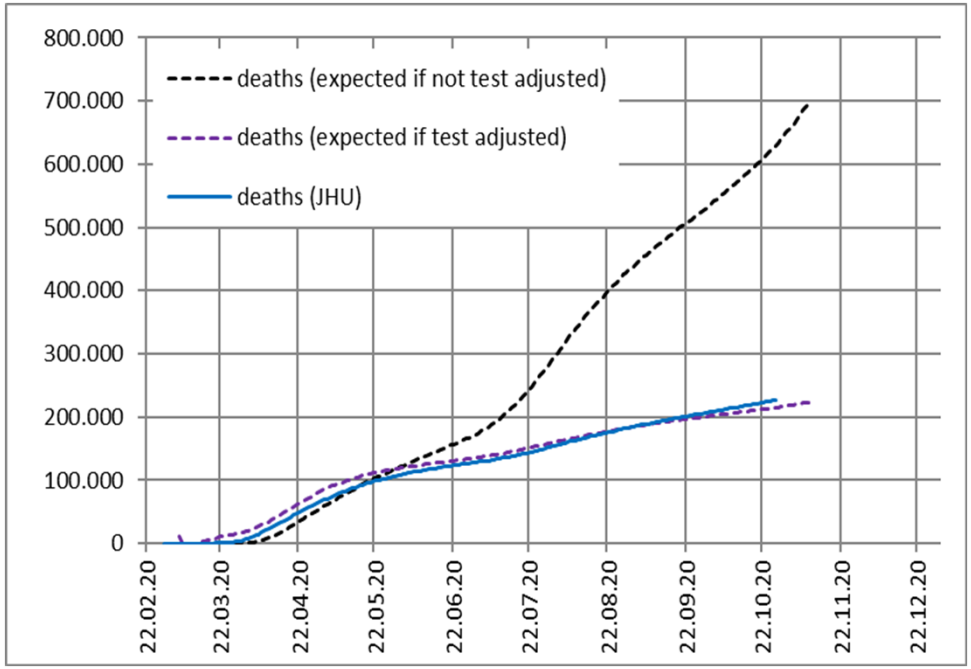
Accumulated deaths data and test adjustment in Germany



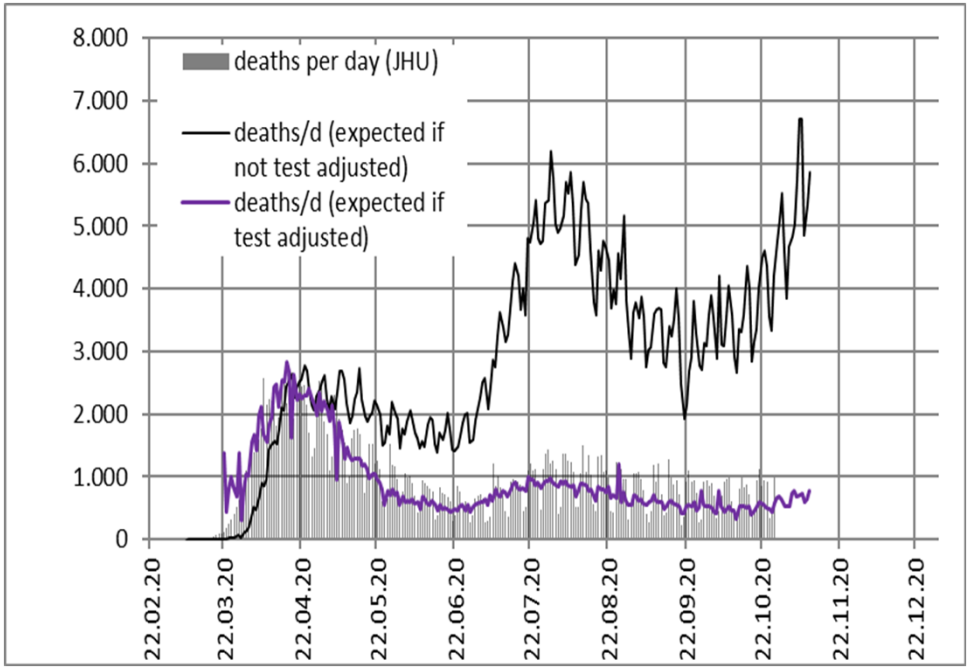
Daily deaths data and test adjustment in Germany

- Only with test adjusted infection numbers we obtain realistic agreement with deaths numbers
- Between the two waves, daily deaths numbers are even smaller then expected after test adjustment
- **Test adjusted mortal calculations** show how many deaths may be expected 13 days ahead in Germany
- This prediction makes it possible to plan ahead 13 days the capacities of the medical system

During 1st and 2nd waves, numbers of deaths follow the number of test adjusted infected in USA



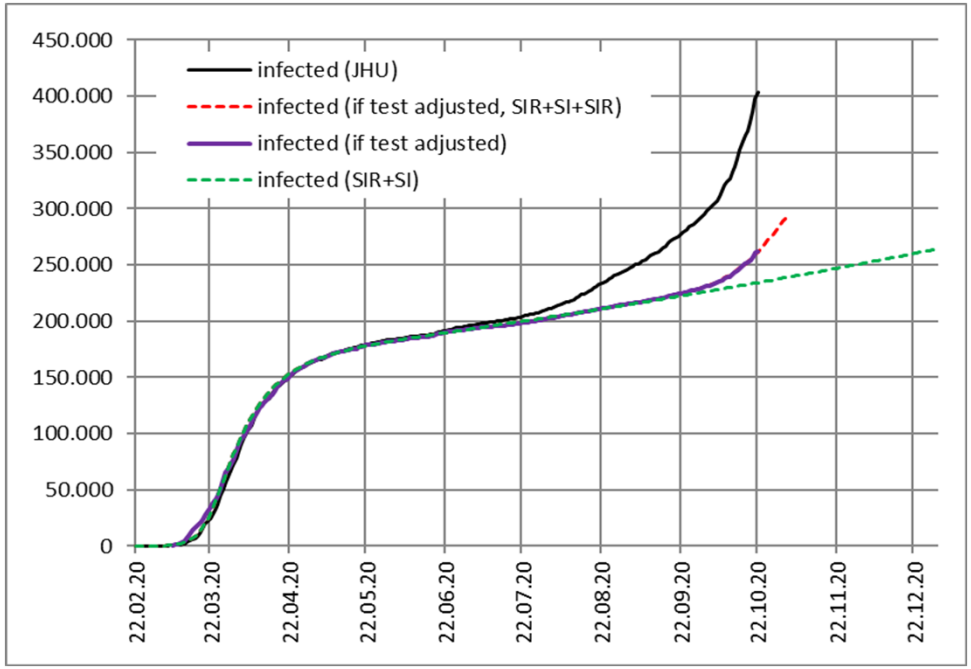
Accumulated deaths data and test adjustment in **USA**



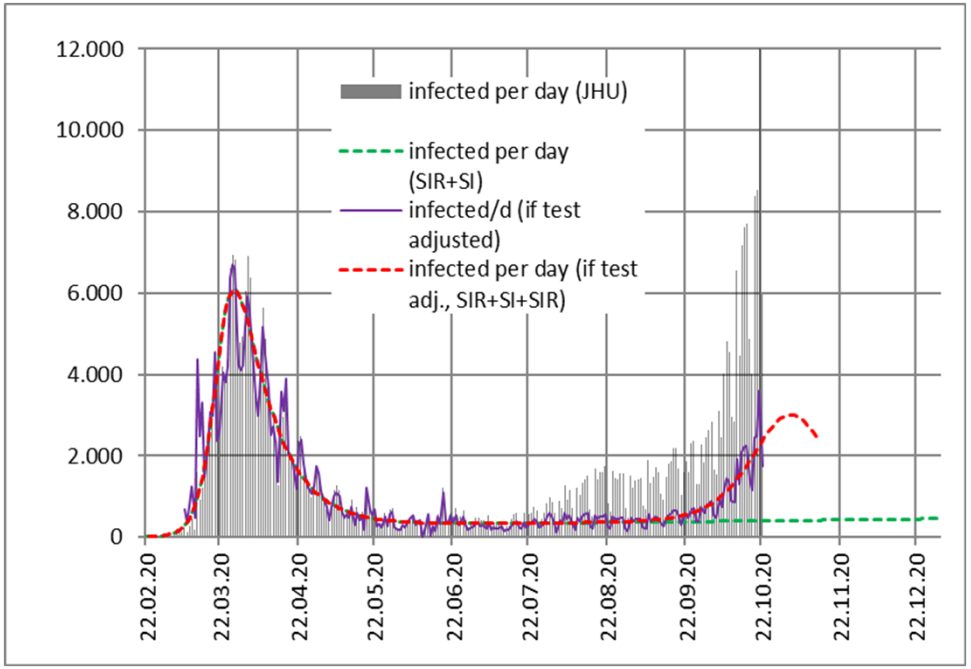
Daily deaths data and test adjustment in **USA**

- Only with test adjusted infection numbers we obtain realistic agreement with deaths numbers
- In USA, at the start of the pandemic only few tests were made
- **Test adjusted mortal calculations** show how many deaths may be expected 14 days ahead in **USA**
- This prediction makes it possible to plan ahead 14 days the capacities of the medical system

Modeling the test adjusted infection data allows for a more realistic outlook into the second wave



Accumulated infected, test adjusted and modeled in Germany



Daily infected, test adjusted and modeled in Germany

- For the 2nd wave, we added a second SIR model to the SIR+SI function
- According to this SIR+SI+SIR model, the 2nd wave of test adjusted infections may be smaller than the present infection data suggest
- Nevertheless, only a clear turning point of the models in the 2nd wave can give certainty

Conclusions

- A strong **relationship** between infections and deaths numbers is observed in the 1st wave in many countries
- The first wave and the following period can be replicated in many countries using a simple **SIR+SI model**
- High infection numbers after June can be explained in Germany and USA mainly by the **increased test volume**
- To estimate the pandemic realistically, it is necessary to **include the test volume**
- Only test adjusted infection numbers serve for **riskiness** and **deaths prediction** of the pandemic

The Excel file as the base of this lecture includes all JHU data and is easy updatable. It will be available soon, as well as the presentation:
https://physik.uni-paderborn.de/en/alumni/mimkes (Publikationen)

Thank you for your attention!

Used models

SIR model for the 1st and further waves

Time dependent variables:

S	Susceptible individuals. At start, S = N	dS= - b*S*I
I	Infectious individuals	dI= b*S*I - g*I
R	Resistant, recovered and removed individuals = “infected” individuals	dR= g*I

Constants:

N Susceptible population S + I + R.
b Infection rate of SIR model
g Recovery rate

Combined SIR+SI model after a wave

Constants:

N_P Inhabitants of a country or district
b_0 Basic infection rate of inhabitants

Infected = (R of the SIR model) + exponential growth from start until whole population is infected (SI-Model)
Infected = (R of the SIR model) / ($N/ N_P + (1 - N/N_P) * EXP(b_0 * t)$)