Predictive Modelling of COVID-19 Pandemic Evolution in Nigeria

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Presentation outlines

- Introduction to COVID-19 modelling and research objective
- Modelling approach, development and modification
- Model validation and results
- Conclusions

Introduction _ COVID-19 world

Nov. 18, 2020		
	Nigeria	World
Confirmed	65,457	55,988,325
Discharged	61,337	39,002,391
Deaths	1,163	1,344,367
Active	2,957	15,641,567
New	152	412,086

- COVID-19 has changed our world.
- Modelling can be used to monitor the impact of various measures.
- Balance modelling parallels the disease spreads by interactions between carriers and the rest of the population.

Research objective:

To predict the COVID-19 Pandemic time evolution in Nigeria.

Modelling approach – balance equation modelling

$$Acc = (In - Out) + Gen \quad (1)$$

$$\frac{dP_i(t)}{dt} = r_i(t) \quad (2)$$

$$\frac{dP}{dt} = k_F P P_H \quad (3)$$

$$\ln\left(P_F / P_{F_0}\right) = k_F B t;\ P_F = P_{F_0} e^{(Kt)} \quad (4)$$

Eq. (4) is an exponential equation. It diverges with time because K has a constant value.

To reflect reality, an expression for K should vanish with time

Key model assumptions:

1. A closed society
2. Two compartments: healthy and confirmed cases
3. Constant healthy population.

Modified Equation

Considering the rapid decline rate of increase in new cases with time divided by the total confirmed, an expression for K should be:

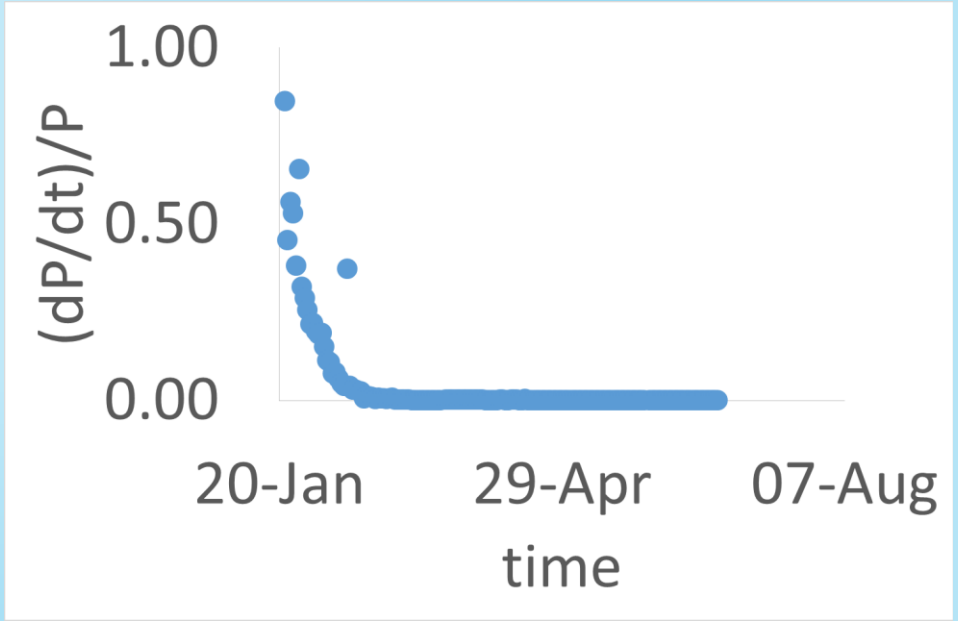
$$\frac{dP}{dt} = K_0 e^{-at} P \qquad (5)$$

After integrating, using initial conditions and rearranging, Eq. (5) becomes:

$$P = e^{\left[\frac{K_0}{a}\left(e^{-at_0} - e^{-at}\right) + \ln P_0\right]} \qquad (6)$$

as the total confirmed cases. Rate of change is

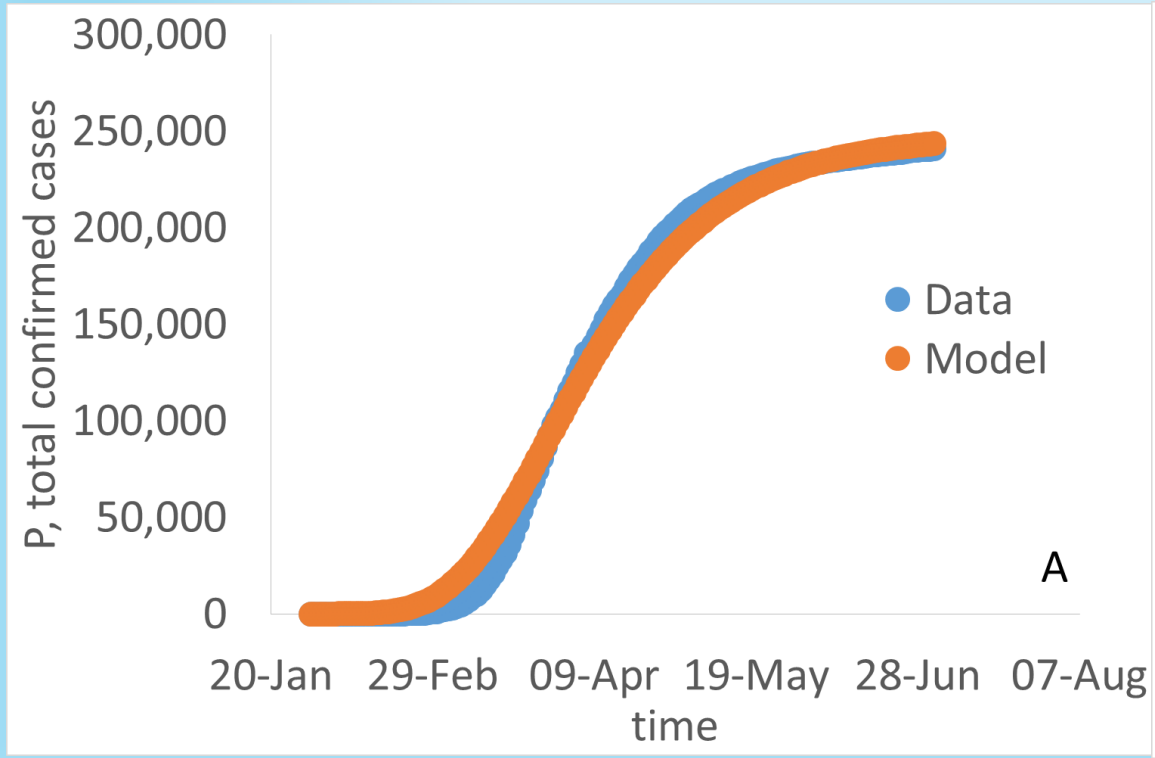
$$\frac{dP}{dt} = K_0 e^{-at} e^{\left[\frac{K_0}{a}\left(e^{-at_0} - e^{-at}\right) + \ln P_0\right]} \qquad (7)$$

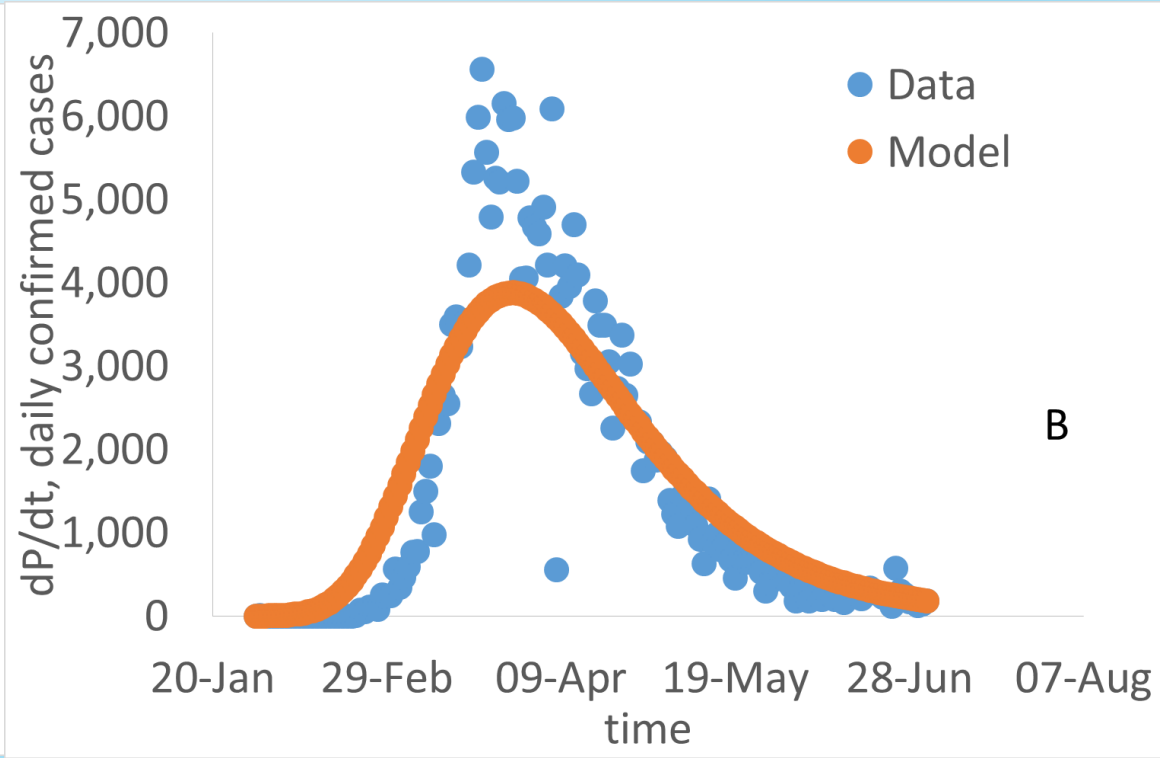


Rate of Covid-19 cases with time using data from China. Data from WHO (2020[a]).

Modelling results for Italy

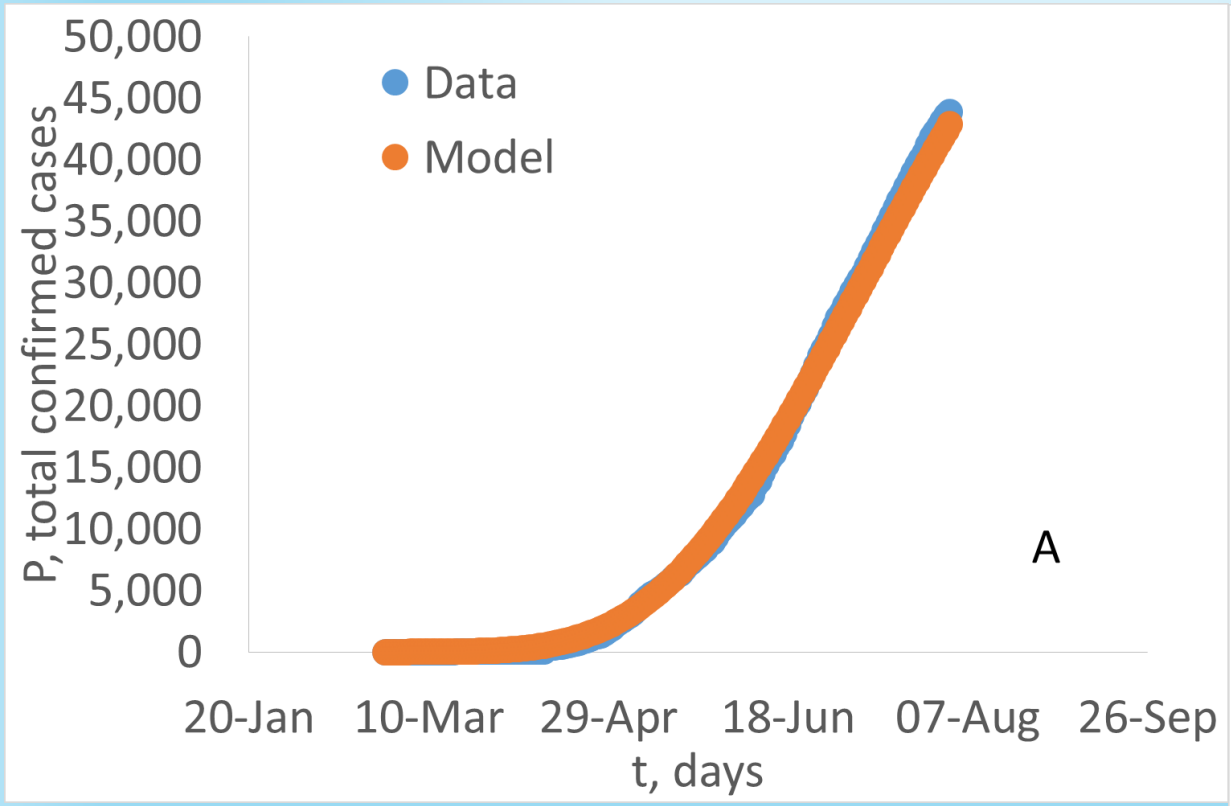
By parameter estimation, values of a and K_0 were obtained. The model was then used and validated as:

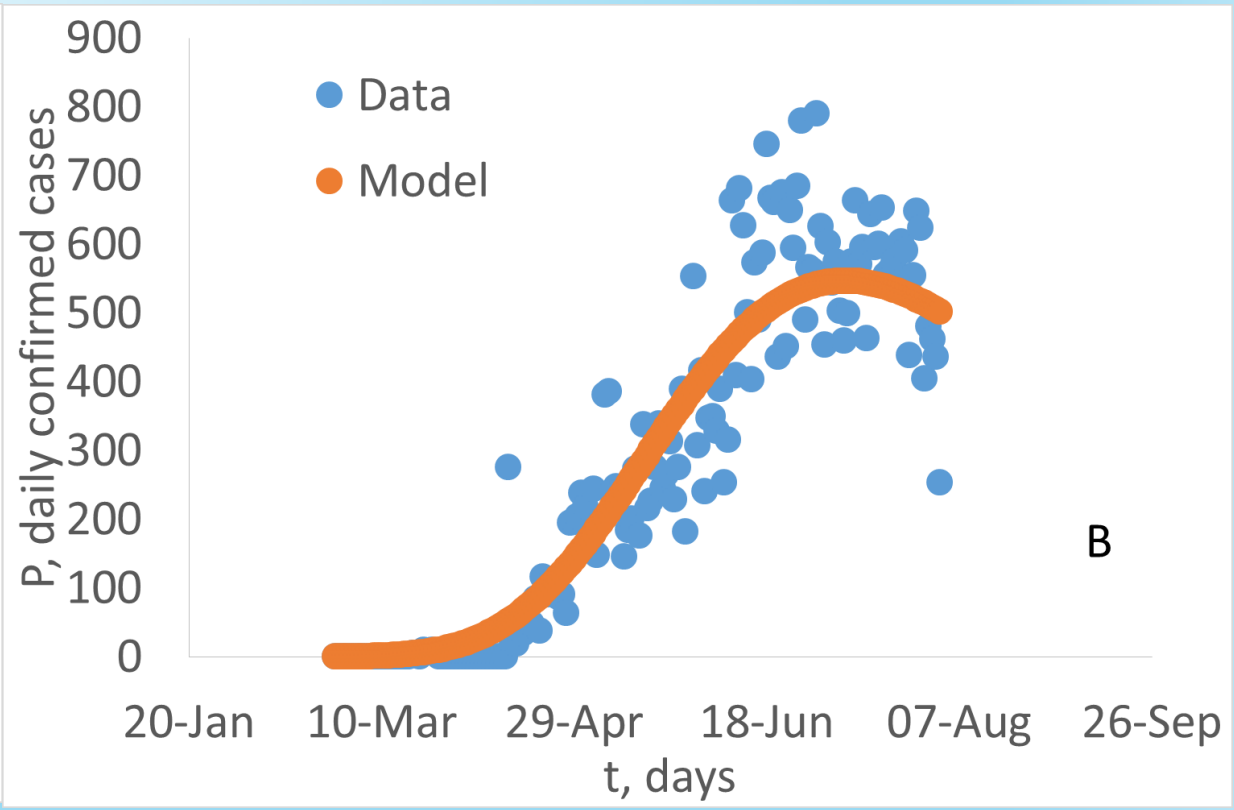




Validation of the modified model 2 using Italy Covid-19 data and the parameters manually adjusted to $a = 0.04257$ and $K_0 = 0.5209$ – A: total confirmed cases and B: daily confirmed cases. Data from WHO (2020[a]).

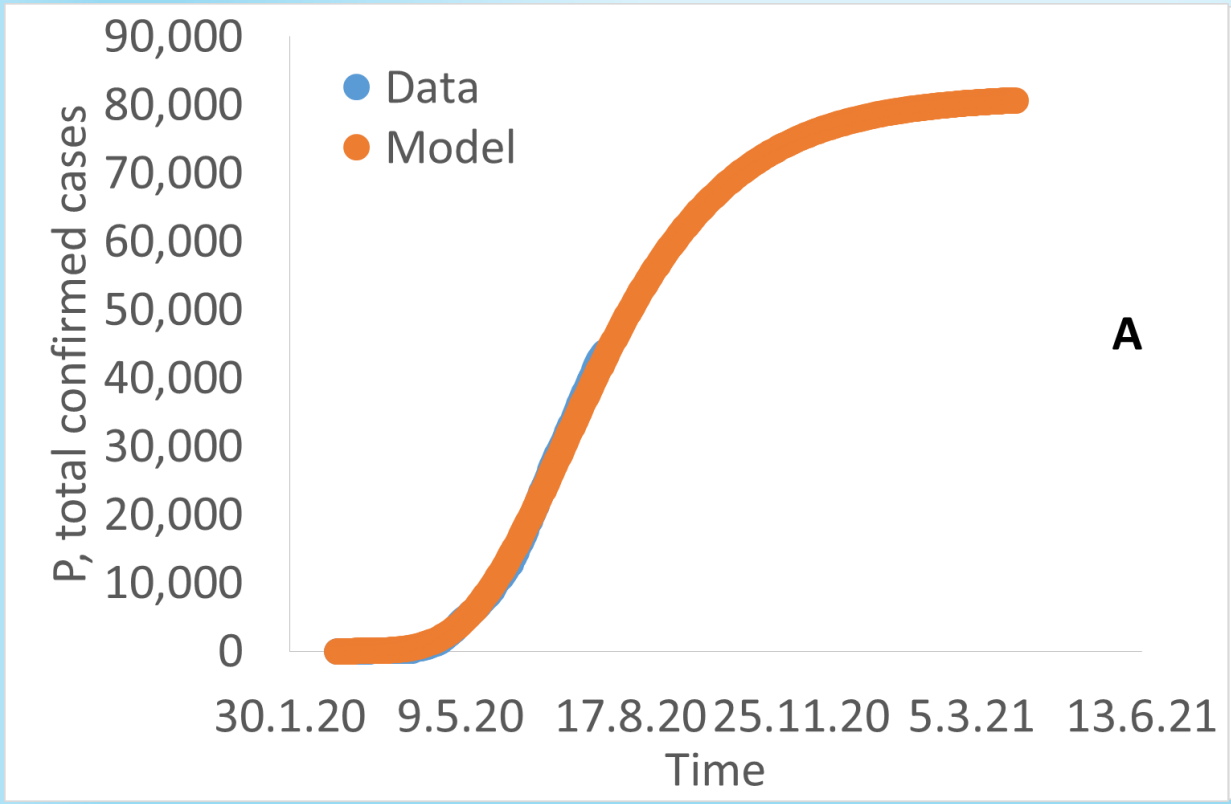
Modelling results for Nigeria

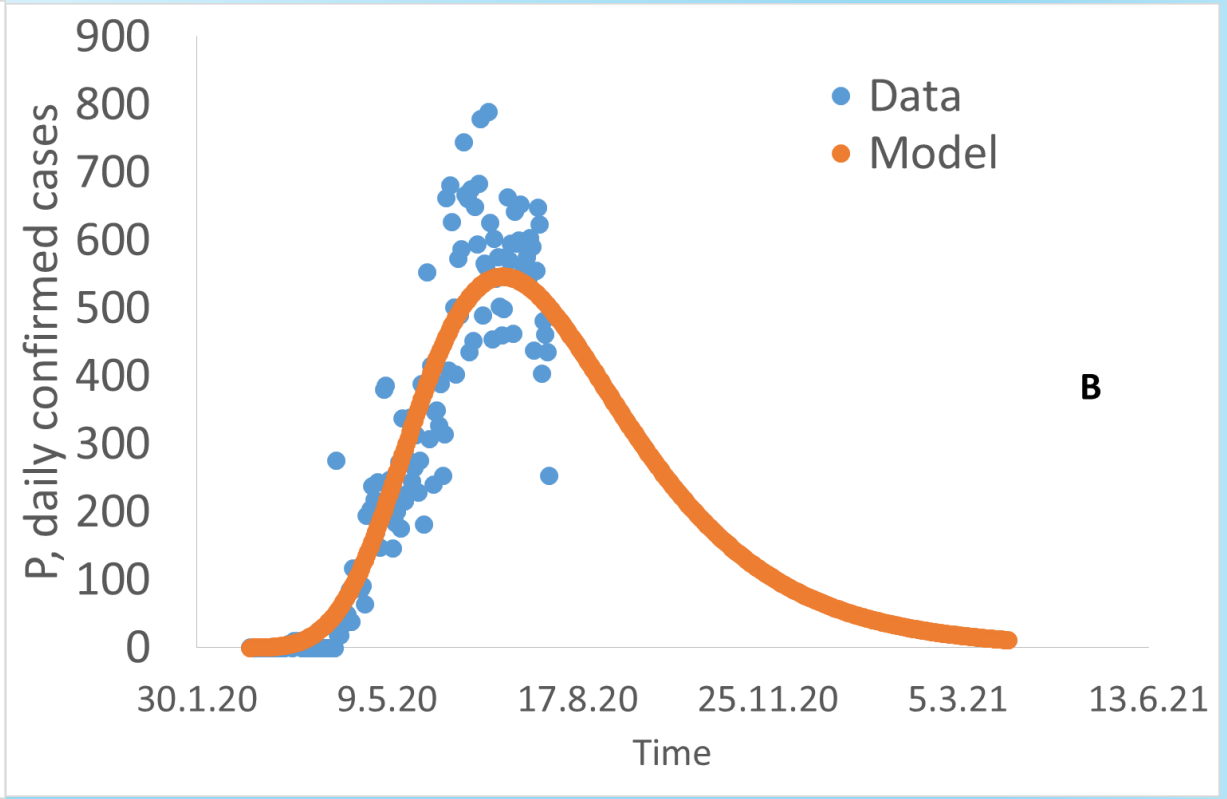




Validation of the modified model 2 using Nigeria Covid-19 data and the parameters manually adjusted to $a = 0.01829$ and $K_0 = 0.2106$ – A: total confirmed cases and B: daily confirmed cases. Data from NCDC (2020).

Future Predictions for Nigeria





Model predictions of the full pandemic evolution of COVID-19 cases in Nigeria; A: Total confirmed cases, P= 81,292
B: Daily recorded cases, peak rise on July 09, 2020. Data from NCDC (2020).

Conclusions

- A model for describing the entire trajectory of the COVID-19 pandemic has been developed
- The resulting model was able to describe the pandemic trend in China and Italy. It could also predict with precision COVID-19 data for Italy and Nigeria.
- Further analysis reveals the Nigerian equilibrium total confirmed cases would be 81,292 and the time for the country to have very low daily record cases would be in March 2021.

References

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- WHO, 2020. WHO Director-General's opening remarks at the media briefing on COVID-19 - 24 February 2020, https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---24-february-2020