COVID-19 Confirmed Cases Prediction as of April 11, 2020

Jointly published by

[1] Chair of Entrepreneurial Risks, D-MTEC, ETH Zurich

[2] Institute of Risk Analysis, Prediction and Management (Risks-X), Academy of Interdisciplinary and Advanced Studies, Southern University of Science and Technology (SUSTech)

[3] Gavekal Intelligence Software

Contacts: Dr. Ke WU (kwu@ethz.ch) and Prof. Dr. Didier SORNETTE (dsornette@ethz.ch)

Summary of the situation:

- Given that the epidemics in many countries have reached or passed the inflection point[1], and the decay in the after-peak trajectory is slower than a classical Logistic model, we have added the Generalized Richards model to our simulations. The Generalized Richards model, which was studied in our first publication [1], has one more parameter than the generalized Logistic model to account for different decaying speed of the after-peak trajectory. Until now, we could not use this model as the additional parameter was introducing instabilities in the calibration due to insufficient data. Now, with more data beyond the inflection point, the Generalized Richards model is warranted. The slower decay of case rates after the peak in many countries may reflect partly a trend of increasing testing combined with a decaying number of new cases. We have adjusted our estimates in positive and medium scenarios based on this Generalized Richards model.

- Europe reaches 820K confirmed cases today with a 4.9% growth rate. The new estimate for the final total confirmed cases is 1.38 million in medium scenario, with 59.6% outbreak process. It is also important to understand that confirmed infections undershoot actual infections by a very large margin. Figure 1 allows us to suggest that all rich cool north[2] countries are converging except Sweden, while hot north[2] and S hemisphere[2] countries are not. The fact that Europe taken as a whole is not in the middle of the distribution (Figure 1) is mainly due to the weight of Russia on the average, which has only 93 confirmed cases per million population.

- The US reaches 0.5 million confirmed cases today with a 7.6% growth rate, compared with 7.8% yesterday. The epidemic in the USA is both geographically diverse and has not yet departed from the generalized exponential model, so the uncertainty is still large for the future developments. Readers can refer to Supplements to COVID-19 Confirmed Cases Prediction (April 7th, 2020)[2] for our analysis on the US test numbers and the confirmed case numbers.

- Spain, Switzerland, Austria, Italy, and Germany are the countries with most mature outbreaks with strong signs that inflection points have been passed. Confirmed cases are a leading indicator while deaths are a lagging indicator and we anticipate that daily mortality numbers may begin to fall ~ 2 to 3 weeks after the peak in new confirmed cases.

- Portugal and Netherlands both record a new high in daily confirmed cases today, which makes the previous identified inflection point invalid. In addition to these two countries, UK, Belgium and France also have not entered an after-peak trajectory. These three countries have high uncertainties and may continue to follow the generalized exponential model.

- Brazil, Sweden, Turkey and Japan continue their previous exponential growth, indicating highly uncertain future scenarios as well, as shown by their non-converged ensemble distributions of final confirmed cases (Figure 1). The transmission in Japan seems to accelerate as do reported deaths, but the death rate figures in Japan are very low and fluctuating from day to day. Unraveling the "epidemic" in Japan remains a work in progress.

---

[1]On a logistic curve, the inflection point indicates where the curvature changes its sign. As we model the total number of confirmed cases, it is equal to the peak of the daily increase curve, after which the daily number of cases is decreasing. If the inflection point has been passed, the worst of the outbreak is over.

[2]https://ethz.ch/content/dam/ethz/special-interest/mtec/chair-of-entrepreneurial-risks-dam/documents/Covid-19/Covid_Supplements_7April2020.pdf

-The irregular dips and spikes in the data most likely reflect data aggregation and reporting delays where numbers not included one day are included in the following day.

Method:

This report updates predictions for the number of COVID-19 confirmed cases at four time horizons (1-day, 5-day, 10-day and end of the outbreak) and for various countries/regions, based on a phenomenological approach detailed in [1]. We employ 4 versions of the generalized logistic growth equation to model the total number of confirmed cases, resulting in a positive, medium and negative scenario for the final expected number of cases. Note that, for countries/regions at early growth stages, the predictions for long-term horizon (10-day and end of the outbreak) are highly uncertain and will vary a lot as the situation changes. The predicted ranges overlap and, as time passes, we anticipate our methodology to zero in on more reliable numbers.

Data source: European Centre for Disease Prevention and Control (ECDC) [2] updated every day at 1pm CET, reflecting data collected up to 6:00 and 10:00 CET. Thus the daily data in some countries is one day delayed compared to other online live sources.

Key Figures & Tables:

-In Table 1, we report the latest confirmed cases per million population and the estimated outbreak progress in the positive and medium scenario (today's confirmed cases divided by the estimated total final confirmed case in positive and now additionally in medium scenarios).

-In Table 2, we report the prediction results in each selected country/region at four time horizons (1-day, 5-day, 10-day and end of the outbreak) in three scenarios. The detailed fitting results for each country/region are plotted in the figures at the end of this report.-

-In Figure 1, we present a distribution of the estimated final total confirmed numbers per million population based on the positive and medium scenario.

-In Figure 2, we show the 1-day prediction error of yesterday's report.

Comment: We need to emphasize that reported confirmed cases are a leading indicator that is subject to a large number of extraneous variables such as sampling rate[3], sample targeting and reliability of testing. See note at end of this report. The real number of cases in the population is likely to be many multiples higher than those computed from confirmed tests. **We strongly recommend that national governments should publish the number of daily tests and implement random testing (polling) in the population, to facilitate all modeling work and therefore better understanding of the epidemic to help guide appropriate policy responses.**

[3] For instance, The UK is experiencing issues with raising the testing rate linked to a global shortage of certain key reagents and swabs. From since April 1st, all testing is to be targeted at health sector staff and this will obviously bias future data compared with past data.

Table 1. Current confirmed cases per million population and estimated outbreak progress in positive and medium scenarios (today's confirmed cases divided by the estimated total final confirmed cases in positive and medium scenario). Numbers in brackets are 80% confidence intervals. As positive scenarios predict a smaller final number of total infected cases, the outbreak progress is thus larger in the positive scenario. Note that the estimated final confirmed numbers tend to underestimate the final results, thus the estimated outbreak progress serves both as a lower bound for future developments and as a guide of the dynamics of the evolution of the epidemics[4]. The number of tests per million population and confirmed cases per test are presented in the last two columns based on the information from Wikipedia [3].

	Confirmed per Million Population (Apr-11)	Outbreak Progress in Positive Scenario	Outbreak Progress in Medium Scenario	Tests per Million Population (update date in brackets)	Confirmed Cases per Test (update date in brackets)
Spain	3361	83.9% (79.8%, 88.3%)	81.4% (77.0%, 86.1%)	7596.0 (Mar 21)	5.6% (Mar 21)
Switzerland	2845	81.7% (75.5%, 88.5%)	79.6% (73.2%, 86.2%)	19536.0 (Apr 07)	12.9% (Apr 07)
Italy	2442	82.4% (78.2%, 85.5%)	79.2% (74.5%, 83.5%)	15035.0 (Apr 10)	15.8% (Apr 10)
Belgium	2335	60.7% (49.0%, 71.5%)	60.5% (41.8%, 83.2%)	8392.0 (Apr 10)	25.9% (Apr 10)
Austria	1533	95.4% (89.5%, 101.5%)	95.2% (89.3%, 101.6%)	15835.0 (Apr 11)	9.6% (Apr 11)
United States	1533	54.9% (43.1%, 64.3%)	48.5% (37.9%, 66.7%)	7804.0 (Apr 10)	18.2% (Apr 10)
Portugal	1505	48.9% (15.0%, 87.5%)	41.1% (0.2%, 62.7%)	12760.0 (Apr 08)	9.5% (Apr 08)
Germany	1419	76.7% (70.8%, 82.0%)	74.0% (66.8%, 81.8%)	15850.0 (Apr 08)	7.8% (Apr 08)
France	1354	72.9% (61.0%, 82.5%)	70.7% (54.2%, 85.5%)	4981.0 (Apr 07)	22.3% (Apr 07)
Netherlands	1340	61.4% (52.7%, 68.8%)	56.5% (45.3%, 73.4%)	5827.0 (Apr 08)	19.3% (Apr 08)
Europe	1100	65.4% (60.2%, 70.1%)	59.6% (53.6%, 67.3%)	NA	NA
United Kingdom	1057	58.2% (48.9%, 66.7%)	54.1% (38.8%, 72.8%)	3991.0 (Apr 11)	26.1% (Apr 11)
Sweden	951	44.6% (21.7%, 58.5%)	Not reliable	6383.0 (Apr 07)	13.2% (Apr 07)
Iran	834	Not reliable	Not reliable	2916.0 (Apr 10)	27.3% (Apr 10)
Turkey	571	30.6% (5.1%, 88.3%)	18.0% (0.0%, 40.9%)	4093.0 (Apr 11)	13.8% (Apr 11)
South Korea	202	Not reliable	Not reliable	9872.0 (Apr 11)	2.0% (Apr 11)
Brazil	94	23.2% (0.0%, 50.3%)	Not reliable	261.0 (Apr 02)	12.5% (Apr 02)
Japan	47	Not reliable	Not reliable	594.0 (Apr 11)	8.0% (Apr 11)

[4]One uncertainty with Italy (and other countries) is whether the main outbreak that is focused on the North may spread through other parts of the country. In other words, does the dynamics aggregated over a whole country represent correctly the dynamics in different parts?

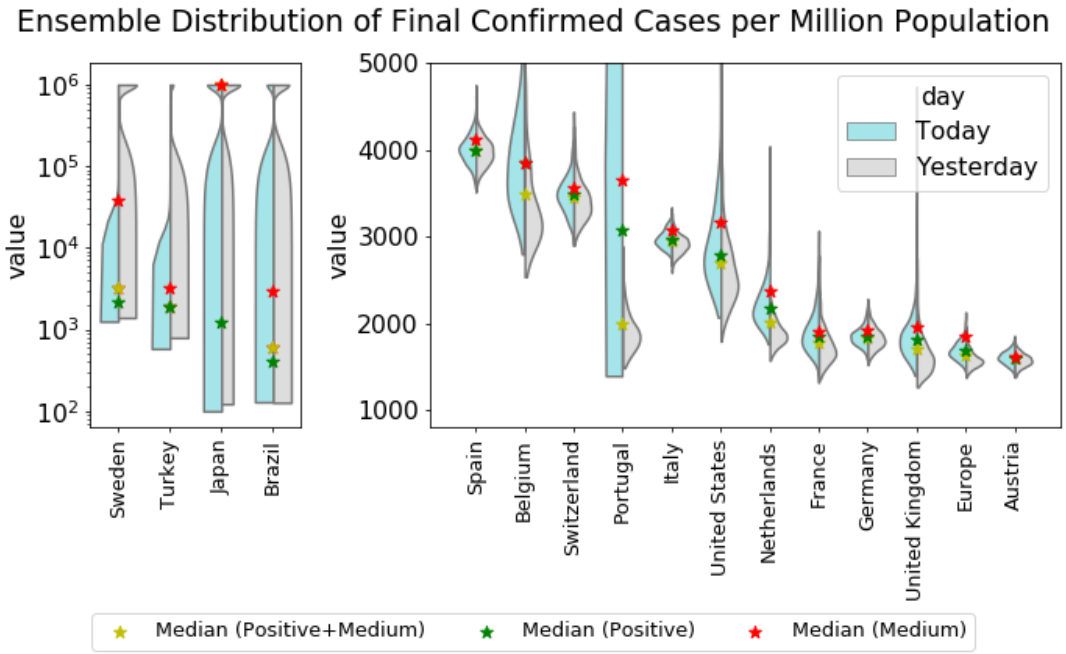


Figure 1. Violin plot of the distributions of the final total number of confirmed cases per million derived by combining the distributions of the positive and medium scenarios using now the Generalised Richards model. The left side of each violin in cyan is today's distribution, while the right side of each violin in grey is yesterday's distribution. The model setup in the negative scenario does not incorporate a maximum saturation number and thus cannot be used. The yellow star indicates the median prediction for the combined distribution, while the green and red stars indicate the median of the positive and of the medium scenarios respectively. Note that, where we have >1 million infections per 1 million of population, the results are deemed to be unreliable (Table 2).

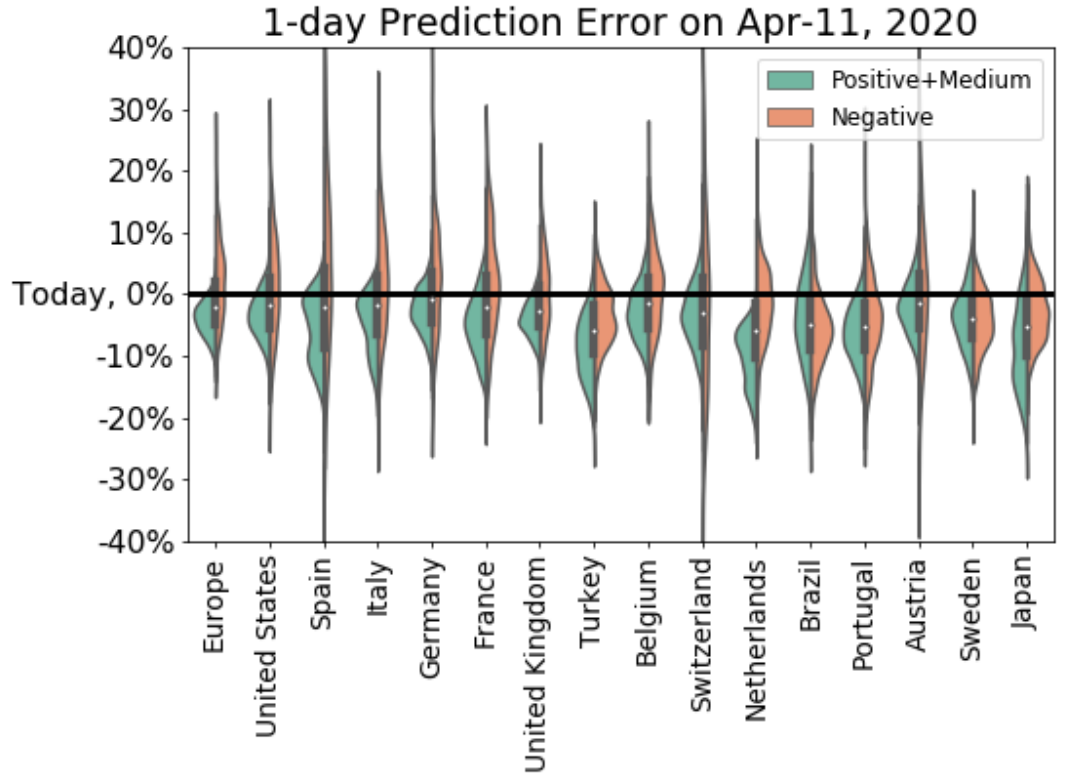


Figure 2. One-day prediction error of the 13 countries/regions. The horizontal line corresponds to today's empirical data. We show the full distribution of errors for each of the two scenarios.

Table 2. Predictions for the number of confirmed cases at four time horizons (1-day, 5-day, 10-day and end of the outbreak) and for various countries/regions, now based on the Generalised Richards model [1]. The values in parentheses are 80% prediction intervals based on 500 simulations using a negative binomial error structure. In Today's validation column, today's empirical data is presented below yesterday's 1-day predictive interval. "Not reliable" is declared if more than 10% of the simulations produce extreme numbers (larger than total population). All numbers are in thousands.

Country	Scenario*	Today's validation	12-Apr	16-Apr	21-Apr	Final Total Confirmed
Europe	Positive	(750, 798) 821	847 (825, 868)	961 (932, 990)	1070 (1030, 1110)	1260 (1170, 1360)
	Medium	(784, 826) 821	842 (823, 861)	964 (939, 989)	1080 (1040, 1130)	1380 (1220, 1530)
	Negative	(769, 916) 821	878 (796, 953)	1070 (984, 1180)	1360 (1230, 1510)	Not Reliable
United States	Positive	(457, 510) 502	525 (502, 552)	644 (606, 683)	756 (690, 829)	913 (779, 1160)
	Medium	(466, 509) 502	524 (507, 540)	643 (610, 673)	764 (688, 825)	1030 (752, 1320)
	Negative	(455, 564) 502	546 (489, 603)	734 (654, 815)	1020 (888, 1180)	Not Reliable
Spain	Positive	(134, 149) 157	160 (154, 166)	171 (165, 178)	180 (172, 187)	187 (178, 197)
	Medium	(150, 161) 157	158 (154, 163)	171 (166, 177)	181 (175, 188)	193 (182, 204)
	Negative	(135, 201) 157	166 (132, 208)	204 (164, 254)	257 (203, 331)	Not Reliable
Italy	Positive	(128, 144) 148	149 (145, 154)	159 (155, 164)	167 (162, 174)	179 (173, 189)
	Medium	(141, 150) 148	148 (145, 153)	159 (154, 163)	168 (163, 174)	186 (177, 198)
	Negative	(135, 169) 148	155 (138, 173)	180 (159, 200)	211 (186, 235)	Not Reliable
Germany	Positive	(108, 119) 118	121 (116, 125)	132 (127, 138)	142 (135, 149)	153 (143, 166)
	Medium	(112, 121) 118	120 (115, 125)	133 (127, 138)	143 (136, 151)	159 (144, 176)
	Negative	(107, 136) 118	125 (110, 141)	152 (135, 171)	190 (168, 217)	Not Reliable
France	Positive	(79.5, 91.8) 90.7	92.4 (86.2, 98.6)	103 (96, 112)	113 (103, 124)	124 (110, 149)
	Medium	(81.8, 93.1) 90.7	92.1 (86.3, 98.5)	104 (95.2, 111)	113 (101, 126)	128 (106, 167)
	Negative	(83, 103) 90.7	96.3 (87.4, 109)	118 (107, 133)	150 (135, 171)	Not Reliable
United Kingdom	Positive	(64.7, 71) 70.3	73 (70.3, 76)	89.1 (85.2, 94.1)	103 (95.9, 113)	121 (105, 144)
	Medium	(64.7, 69.9) 70.3	72.9 (70.2, 75.5)	89.4 (83.9, 94.2)	105 (91.3, 116)	130 (96.6, 181)
	Negative	(64.5, 76.6) 70.3	76.2 (70.2, 83)	103 (94.7, 113)	146 (132, 166)	Not Reliable
Turkey	Positive	(38.9, 43.8) 47	49.5 (47.2, 51.8)	66.8 (53.1, 73.9)	87.5 (53.2, 110)	154 (53.2, 929)
	Medium	(42.4, 47.2) 47	49.7 (47, 52.3)	69.8 (64, 75.2)	97.8 (81.3, 114)	Not Reliable
	Negative	(42.6, 48.6) 47	50.3 (47.6, 53.3)	73.1 (68.4, 77.6)	110 (100, 119)	Not Reliable

Belgium	Positive	(24.5, 28) 26.7	27.6 (26.2, 29.2)	32.3 (30.2, 34.5)	36.7 (33.6, 40.5)	43.9 (37.3, 54.4)
	Medium	(24.3, 27.1) 26.7	27.6 (26.1, 29.2)	32 (29.7, 34.4)	36.3 (31.6, 40.6)	44 (32.1, 63.8)
	Negative	(24.4, 29.2) 26.7	28.6 (26.1, 30.9)	36.4 (33.1, 39.5)	48 (43.1, 53)	Not Reliable
Switzerland	Positive	(21.7, 24.6) 24.2	25.3 (23.9, 26.8)	27 (25.4, 28.5)	28.3 (26.3, 30)	29.7 (27.4, 32.1)
	Medium	(23.2, 26) 24.2	25.2 (24, 26.6)	26.9 (25.7, 28.4)	28.4 (26.8, 30.1)	30.4 (28.1, 33.1)
	Negative	(19.9, 30.6) 24.2	25.8 (21.1, 31.7)	30.5 (24.7, 37.5)	37.1 (29.3, 46.6)	Not Reliable
Netherlands	Positive	(19.2, 21.7) 23.1	24.1 (23.3, 25.1)	27.5 (26.4, 29)	30.9 (29.2, 33.1)	37.6 (33.6, 43.8)
	Medium	(21.7, 23.3) 23.1	23.4 (22.5, 24.3)	27 (25.6, 28.3)	30.7 (28.2, 32.9)	40.9 (31.5, 51)
	Negative	(22.3, 25.8) 23.1	25.5 (23.6, 27.6)	31.3 (28.8, 34.1)	39.6 (36.1, 43.9)	Not Reliable
Brazil	Positive	(16.9, 19.8) 19.6	21.3 (19.5, 23.2)	30.8 (26.8, 34.9)	45.1 (33, 60.4)	Not Reliable
	Medium	(17.8, 21.2) 19.6	20.2 (18.8, 21.9)	29.5 (26, 33)	44.1 (31.9, 54.3)	Not Reliable
	Negative	(17.1, 20.1) 19.6	20.5 (18.9, 22.1)	30.7 (28, 33.7)	47.9 (42, 56.6)	Not Reliable
Portugal	Positive	(13.6, 15.6) 15.5	16.2 (15, 17.4)	19 (16.9, 21.3)	22.1 (17.6, 26.6)	31.6 (17.7, 103)
	Medium	(13.5, 15.3) 15.5	16.1 (15, 17.5)	19.6 (17.9, 21.6)	23.5 (20.5, 27.7)	37.6 (24.7, 6530)
	Negative	(13.4, 16.2) 15.5	16.3 (15, 17.9)	20.8 (18.9, 22.8)	27.1 (24.4, 30.7)	Not Reliable
Austria	Positive	(12.6, 14.2) 13.6	13.6 (12.8, 14.4)	13.9 (13.1, 14.8)	14.1 (13.3, 15)	14.2 (13.4, 15.1)
	Medium	(12.5, 14) 13.6	13.6 (12.8, 14.3)	13.9 (13.1, 14.7)	14.1 (13.3, 15)	14.2 (13.4, 15.2)
	Negative	(11.8, 15.7) 13.6	13.9 (12, 15.9)	16.2 (13.9, 18.5)	19.2 (16.3, 22.3)	Not Reliable
Sweden	Positive	(8.75, 10.1) 9.68	9.94 (9.37, 10.6)	12.4 (11.4, 13.7)	15.2 (13.5, 17.9)	21.7 (16.6, 44.6)
	Medium	(8.68, 9.82) 9.68	9.78 (9.18, 10.4)	12.6 (11.7, 13.4)	16.6 (14.5, 18.3)	Not Reliable
	Negative	(8.68, 9.86) 9.68	9.86 (9.27, 10.5)	12.7 (12, 13.7)	17.2 (15.9, 18.6)	Not Reliable
Japan	Positive	(4.85, 5.54) 6	5.83 (5.5, 6.21)	9.17 (8.17, 10)	15.8 (11.7, 18.7)	Not Reliable
	Medium	(5.48, 6.25) 6	6.63 (6.21, 7.12)	9.44 (8.7, 10.2)	14.7 (12.6, 16.2)	Not Reliable
	Negative	(5.48, 6.26) 6	6.67 (6.23, 7.14)	9.51 (8.83, 10.3)	14.9 (13.4, 16.4)	Not Reliable
Iran	Positive	(54.1, 63.5) 68.2	68.3 (65.2, 71.2)	71.3 (67.5, 75.3)	72.5 (68.1, 78.1)	Not Reliable
	Medium	(60.4, 68.4) 68.2	65.6 (61.3, 69.4)	72.9 (67.8, 77.8)	80.1 (73.4, 86.8)	Not Reliable
	Negative	(65.7, 76.4) 68.2	72.8 (67.5, 79.3)	85.2 (78.8, 92.8)	102 (93.7, 111)	Not Reliable

* Note:

-The scenarios are based on the final total confirmed numbers. There is a change from the previous forecasts, as we now use four models, the Generalized Richards Model, Generalized Logistic Model, Logistic Model and Generalized Growth model (see [1] for their presentation). We remove the lowest mean predicted final total confirmed number K among the four models (which is classical statistical method ensuring robustness). Then, the model with the second lowest mean predicted final total confirmed number K is classified as the positive scenario, and the third lowest one is classified as the medium scenario. The negative scenario is based on the Generalized Growth model, which should only describe the early stage of the epidemic outbreak and is therefore least reliable for countries in the more mature stage.

-Trajectories from Iran have largely deviated from a typical logistic type growth (S curve), and can't be properly described by our models. Although we still report its calibration results in Table 1, they should not be taken as reliable in all scenarios and time horizons. This is probably a result of unreliable reported data from Iran.

Limitations of using the statistics of reported confirmed number

It is important to understand what our prediction models show. The predictions are based on cases identified on the basis of testing and they therefore predict the numbers of future positive tests. Relating positive test results to real levels of infection is subject to a large number of biases. It is a fact that the real number of infections is far higher than those recorded in positive tests since only a tiny fraction of any population has been tested. It is also the case that, in most countries, testing is biased towards those who think they are infected. The first bias, therefore, will underestimate the real number of infections while the second bias will tend to overestimate since it is biased towards those who think they are ill.

There are further complications. Depending on the testing protocols used, in some instances false positive results have been obtained. In other words, someone without the disease tested positive, probably because they were infected with some other coronavirus. And in other cases, false negative results were obtained, as was the case with the early testing deployed in the USA.

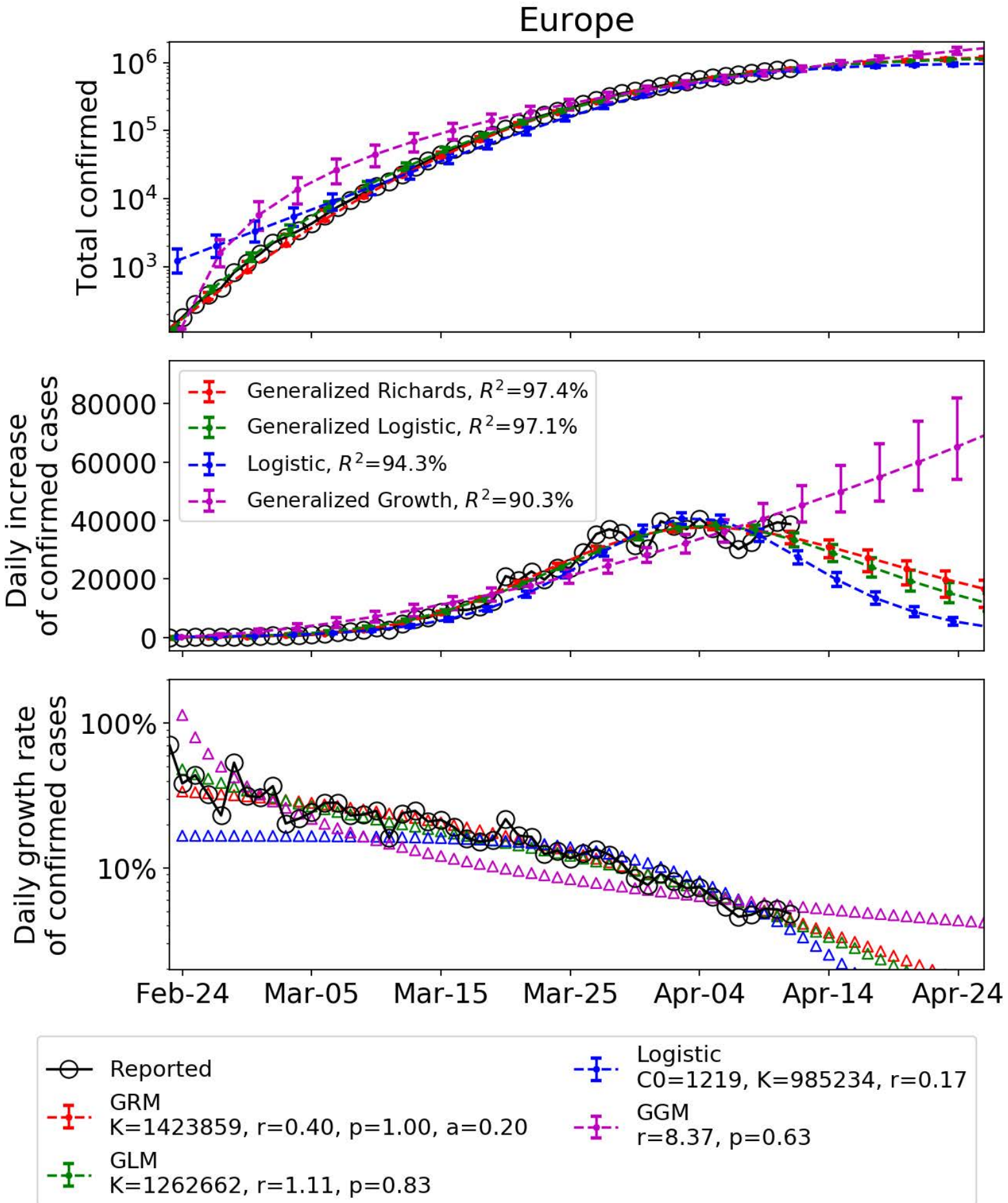
One final complication is the fact that tests are conducted sequentially over time. They do not represent a snapshot of a day in time. Many of those tested early, giving a negative result, may today get a positive result. And many, who tested positive early on, may today be cured.

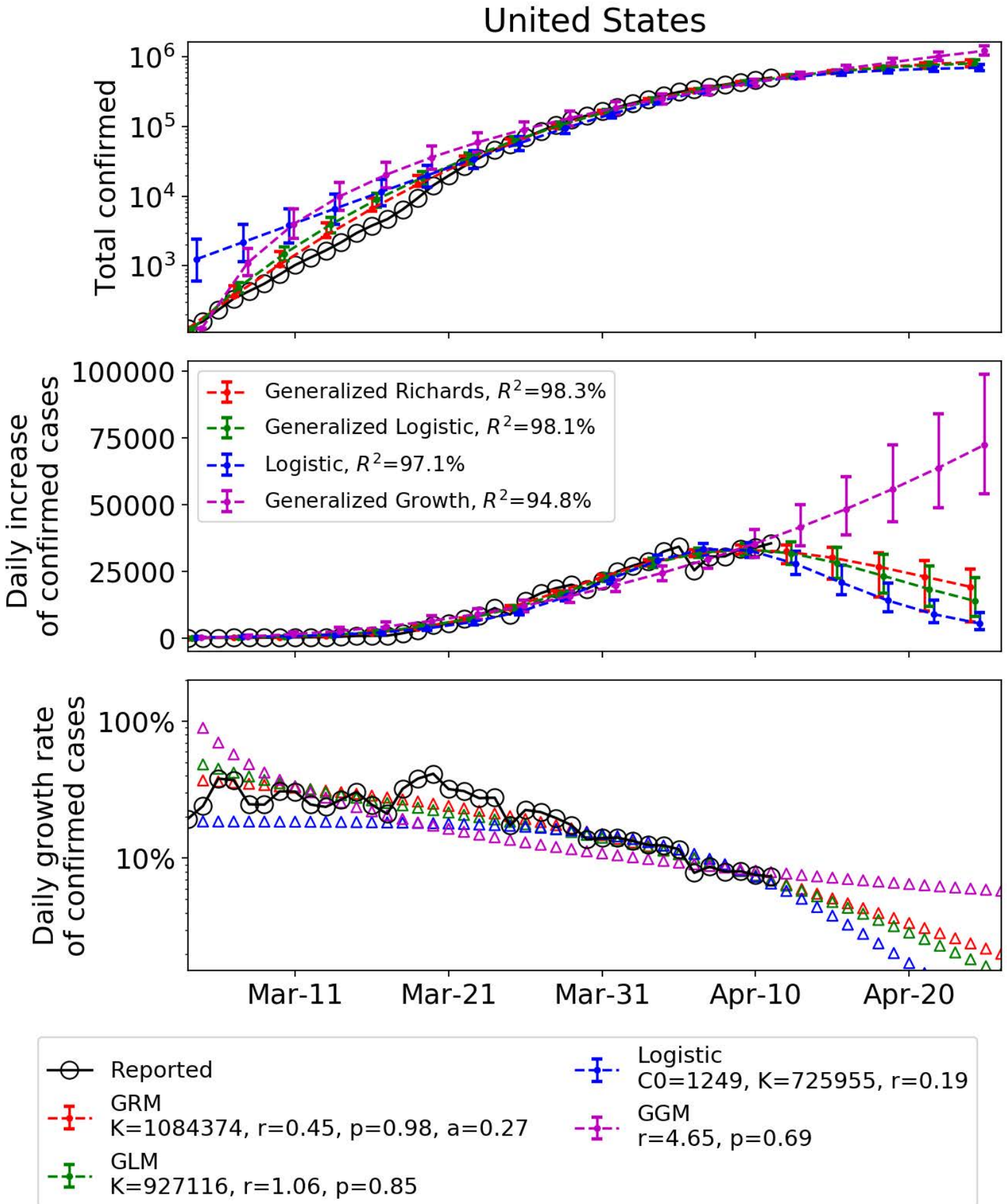
We anticipate that, over time, our methodology will improve and will provide a more accurate picture of the true levels of infection and where they are headed.

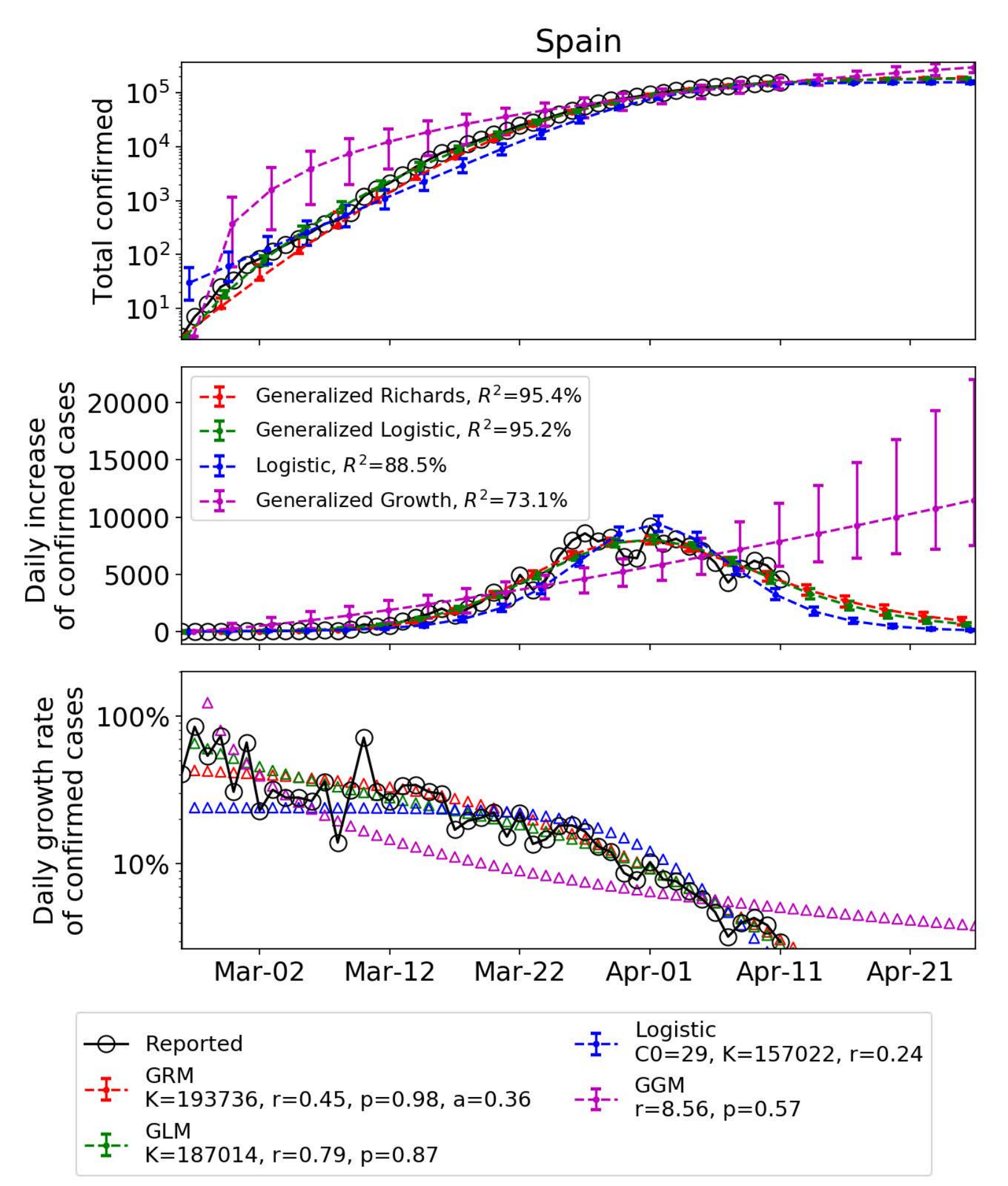
[1] Ke Wu, Didier Darcet, Qian Wang and Didier Sornette, Generalized logistic growth modeling of the COVID-19 outbreak in 29 provinces in China and in the rest of the world, preprint at http://arxiv.org/abs/2003.05681 and
medRxiv: https://medrxiv.org/cgi/content/short/2020.03.11.20034363v1

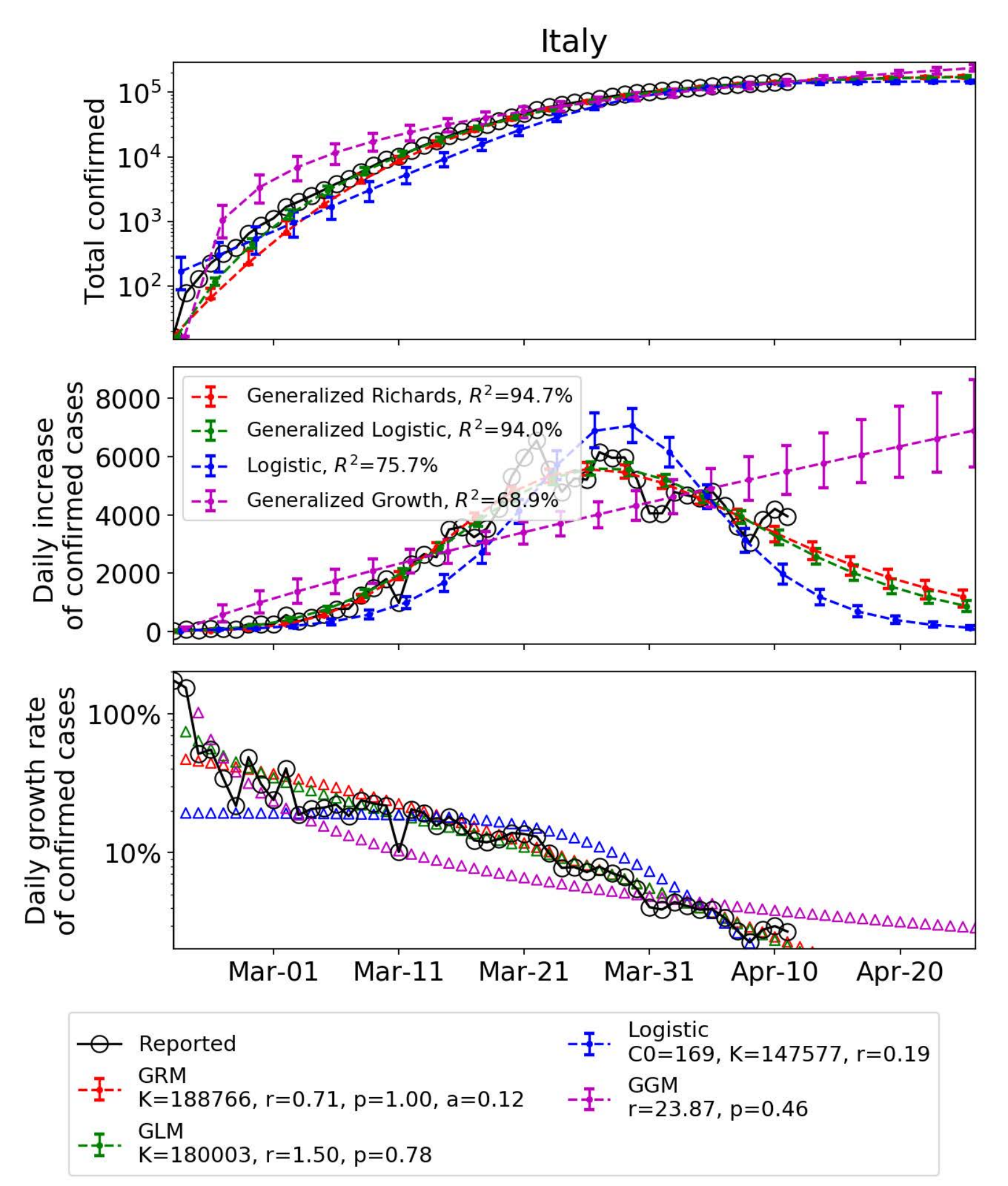
[2] https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

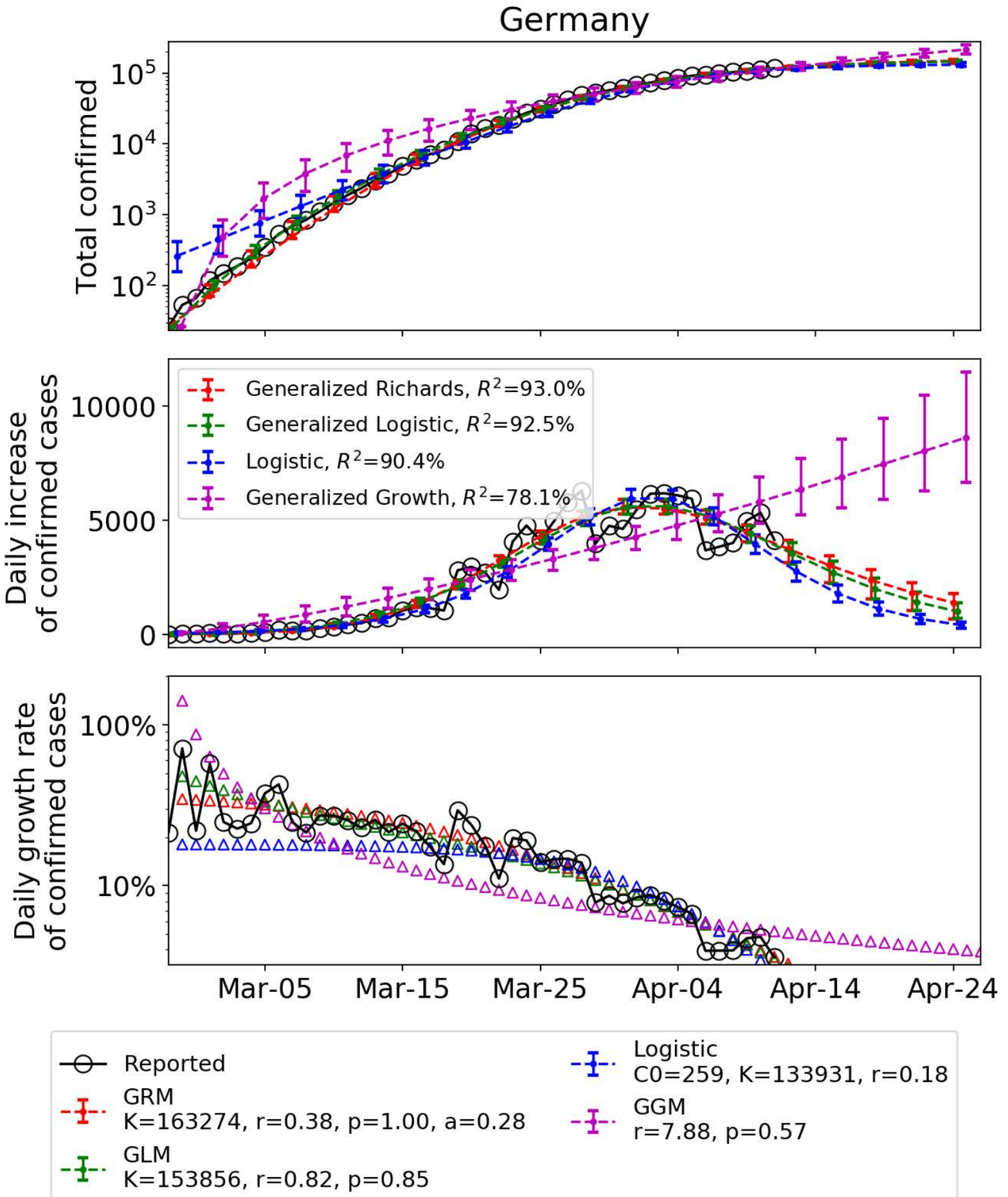
[3] https://en.wikipedia.org/wiki/COVID-19_testing

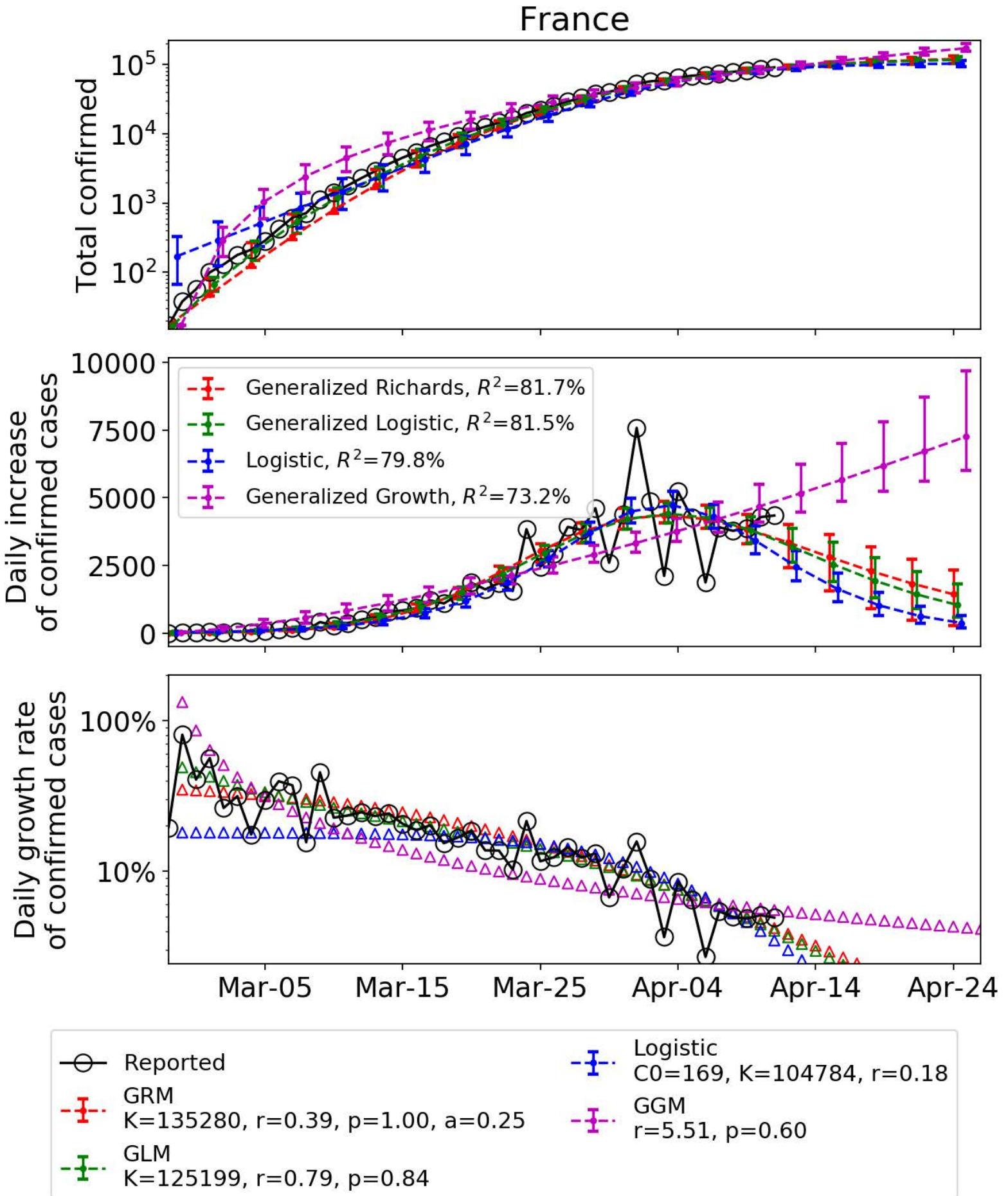

Europe
Total confirmed
10^6
10^5
10^4
10^3
Daily increase of confirmed cases
80000
60000
40000
20000
0
Generalized Richards, R^2=97.4%
Generalized Logistic, R^2=97.1%
Logistic, R^2=94.3%
Generalized Growth, R^2=90.3%
Daily growth rate of confirmed cases
100%
10%
Feb-24
Mar-05
Mar-15
Mar-25
Apr-04
Apr-14
Apr-24
Reported
GRM
K=1423859, r=0.40, p=1.00, a=0.20
GLM
K=1262662, r=1.11, p=0.83
Logistic
C0=1219, K=985234, r=0.17
GGM
r=8.37, p=0.63

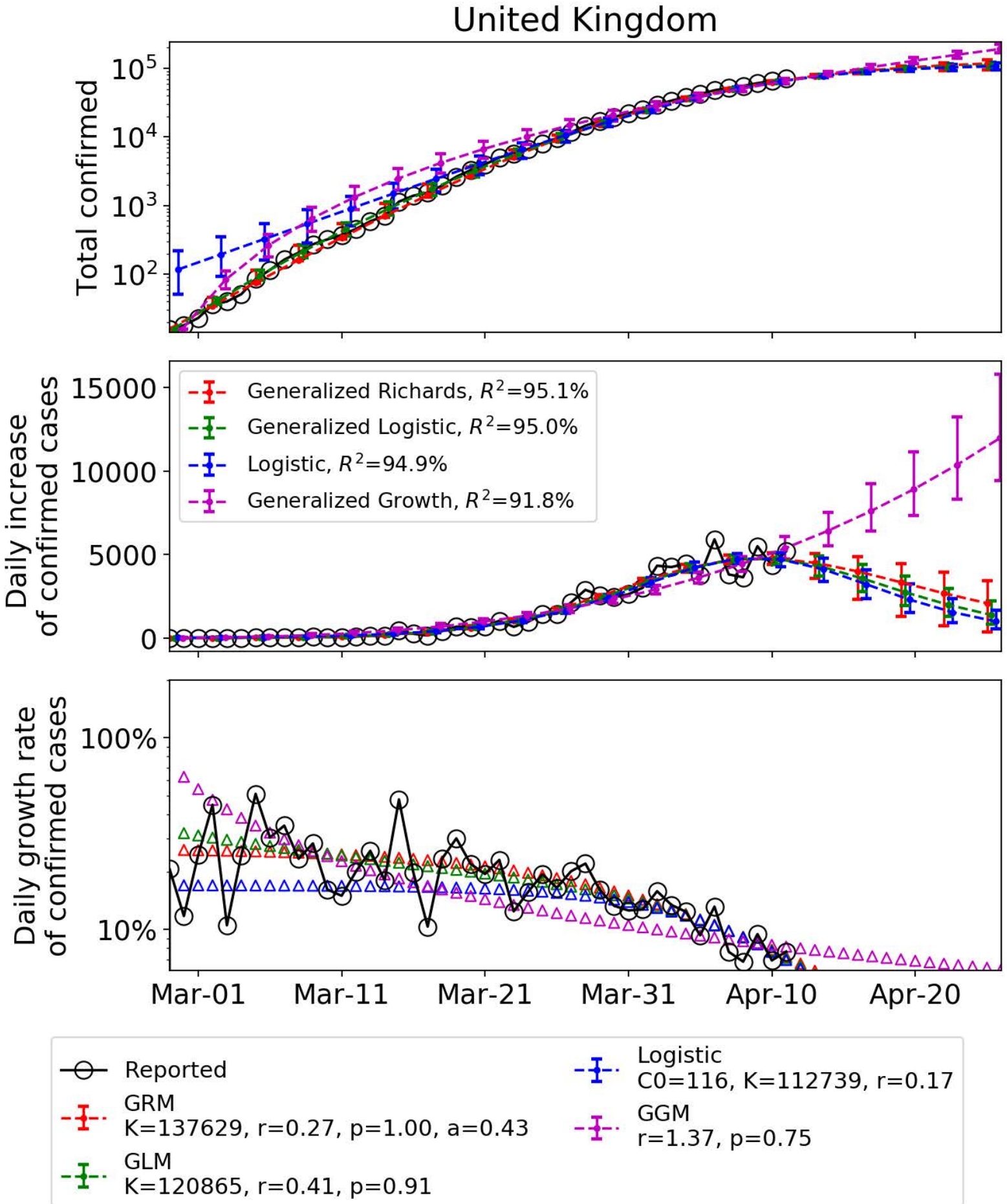

United States
Total confirmed
10^6
10^5
10^4
10^3
Daily increase of confirmed cases
100000
75000
50000
25000
0
Generalized Richards, R^2=98.3%
Generalized Logistic, R^2=98.1%
Logistic, R^2=97.1%
Generalized Growth, R^2=94.8%
Daily growth rate of confirmed cases
100%
10%
Mar-11
Mar-21
Mar-31
Apr-10
Apr-20
Reported
GRM
K=1084374, r=0.45, p=0.98, a=0.27
GLM
K=927116, r=1.06, p=0.85
Logistic
C0=1249, K=725955, r=0.19
GGM
r=4.65, p=0.69

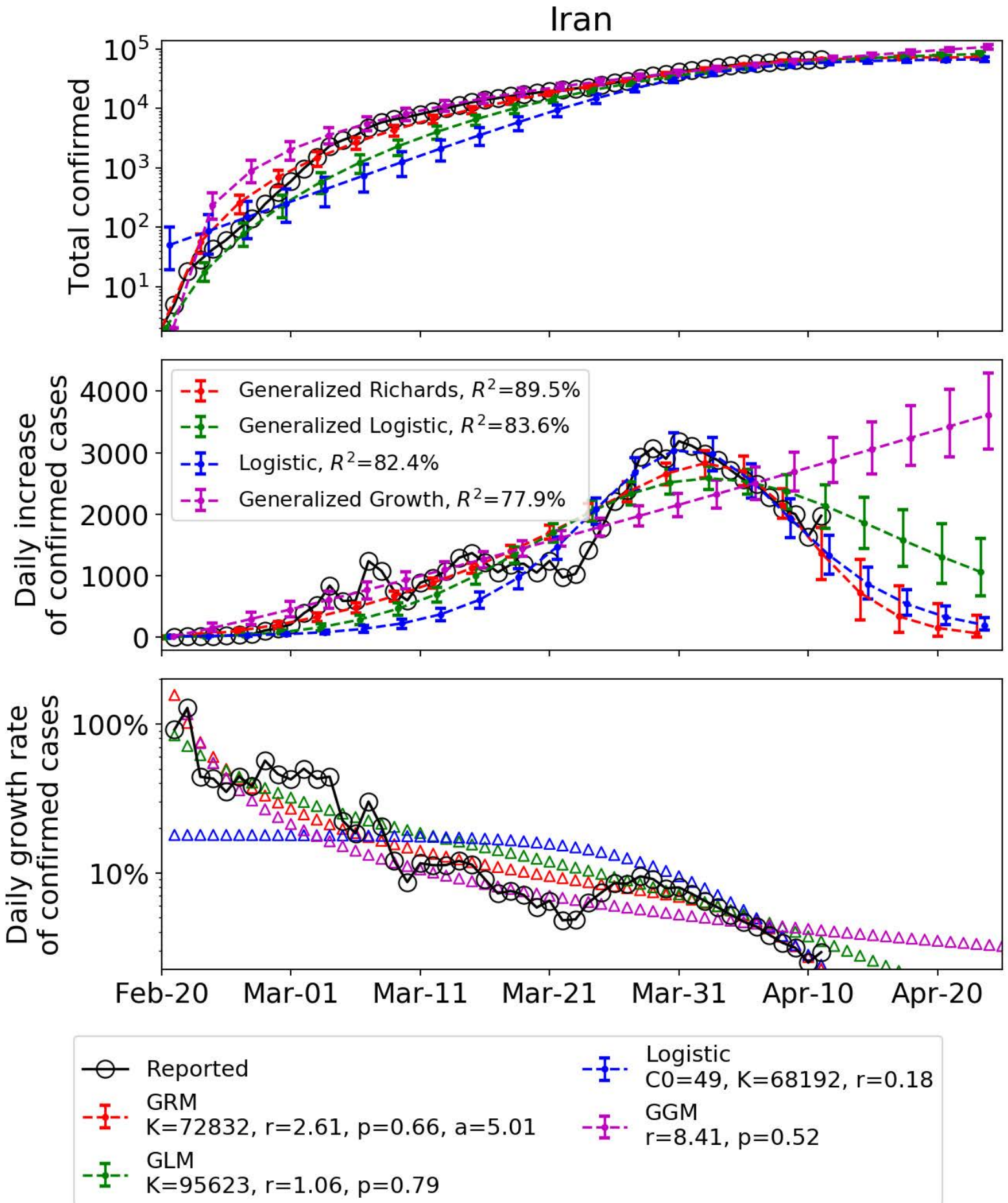

Spain
Total confirmed
10^5
10^4
10^3
10^2
10^1
Daily increase of confirmed cases
20000
15000
10000
5000
0
Generalized Richards, R^2=95.4%
Generalized Logistic, R^2=95.2%
Logistic, R^2=88.5%
Generalized Growth, R^2=73.1%
Daily growth rate of confirmed cases
100%
10%
Mar-02
Mar-12
Mar-22
Apr-01
Apr-11
Apr-21
Reported
GRM
K=193736, r=0.45, p=0.98, a=0.36
GLM
K=187014, r=0.79, p=0.87
Logistic
C0=29, K=157022, r=0.24
GGM
r=8.56, p=0.57

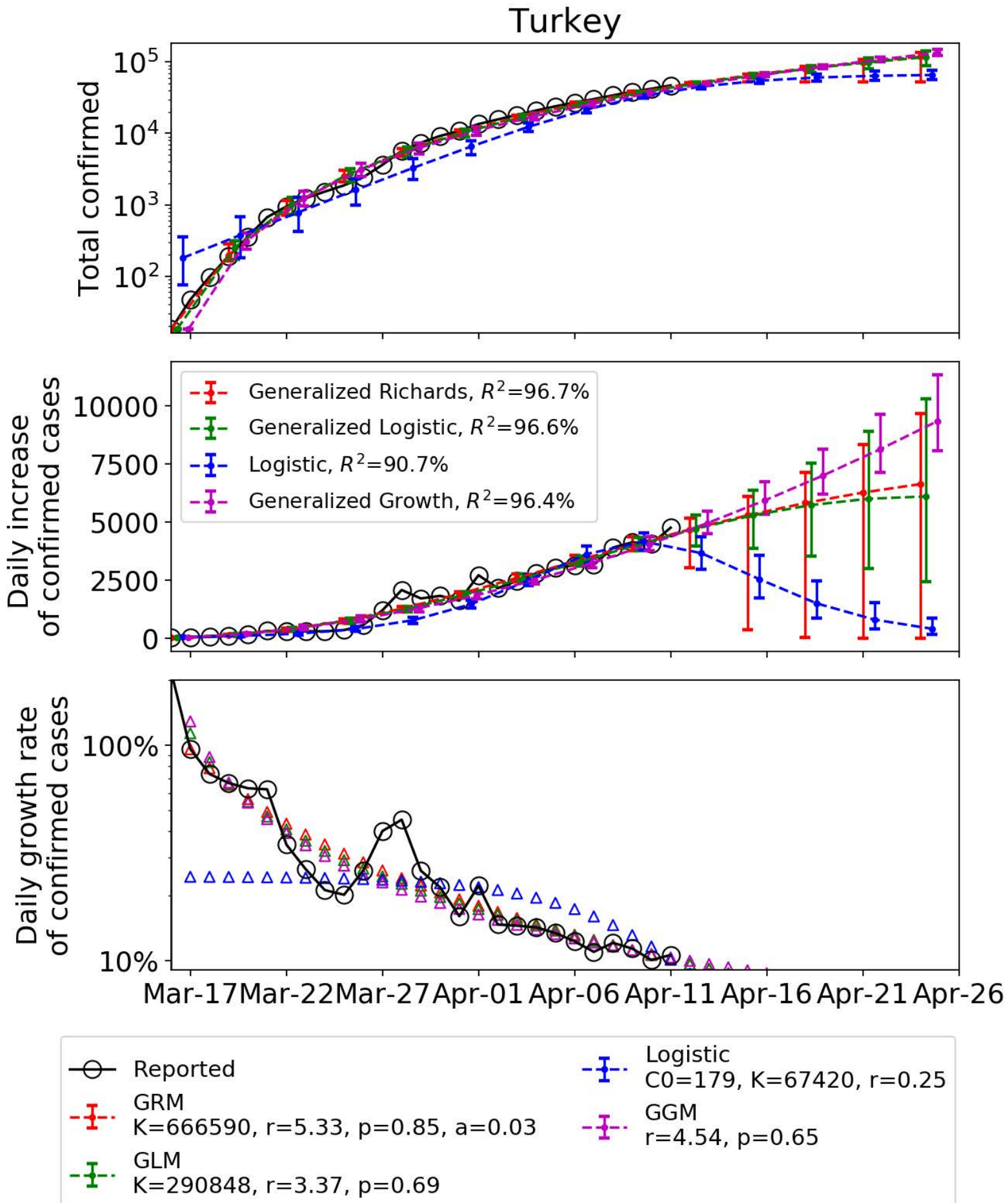

Italy
Total confirmed
10^5
10^4
10^3
10^2
Daily increase of confirmed cases
8000
6000
4000
2000
0
Generalized Richards, R^2=94.7%
Generalized Logistic, R^2=94.0%
Logistic, R^2=75.7%
Generalized Growth, R^2=68.9%
Daily growth rate of confirmed cases
100%
10%
Mar-01
Mar-11
Mar-21
Mar-31
Apr-10
Apr-20
Reported
GRM
K=188766, r=0.71, p=1.00, a=0.12
GLM
K=180003, r=1.50, p=0.78
Logistic
C0=169, K=147577, r=0.19
GGM
r=23.87, p=0.46

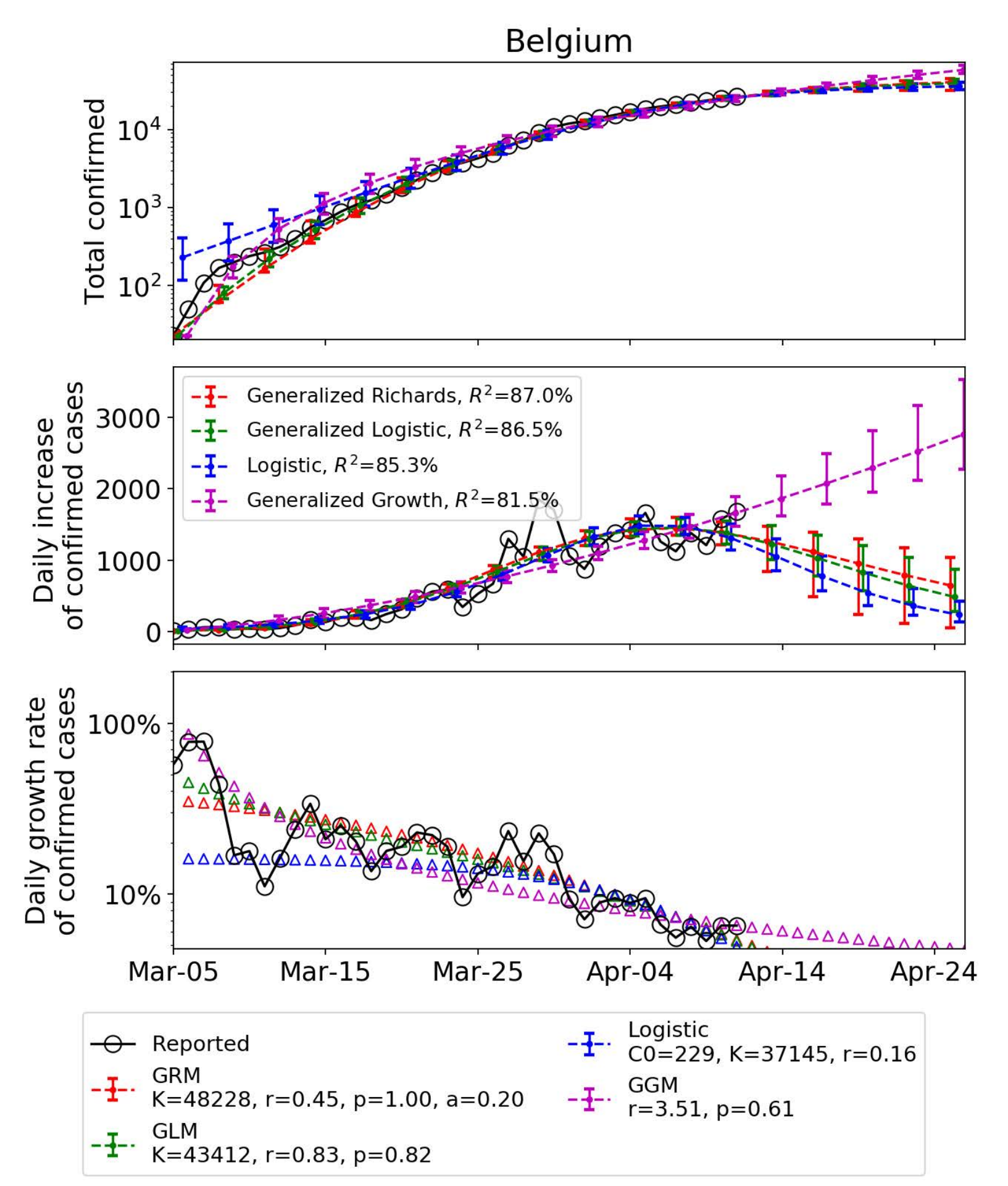

Germany
Total confirmed
10^5
10^4
10^3
10^2
Daily increase of confirmed cases
10000
5000
0
Generalized Richards, R^2=93.0%
Generalized Logistic, R^2=92.5%
Logistic, R^2=90.4%
Generalized Growth, R^2=78.1%
Daily growth rate of confirmed cases
100%
10%
Mar-05
Mar-15
Mar-25
Apr-04
Apr-14
Apr-24
Reported
GRM
K=163274, r=0.38, p=1.00, a=0.28
GLM
K=153856, r=0.82, p=0.85
Logistic
C0=259, K=133931, r=0.18
GGM
r=7.88, p=0.57

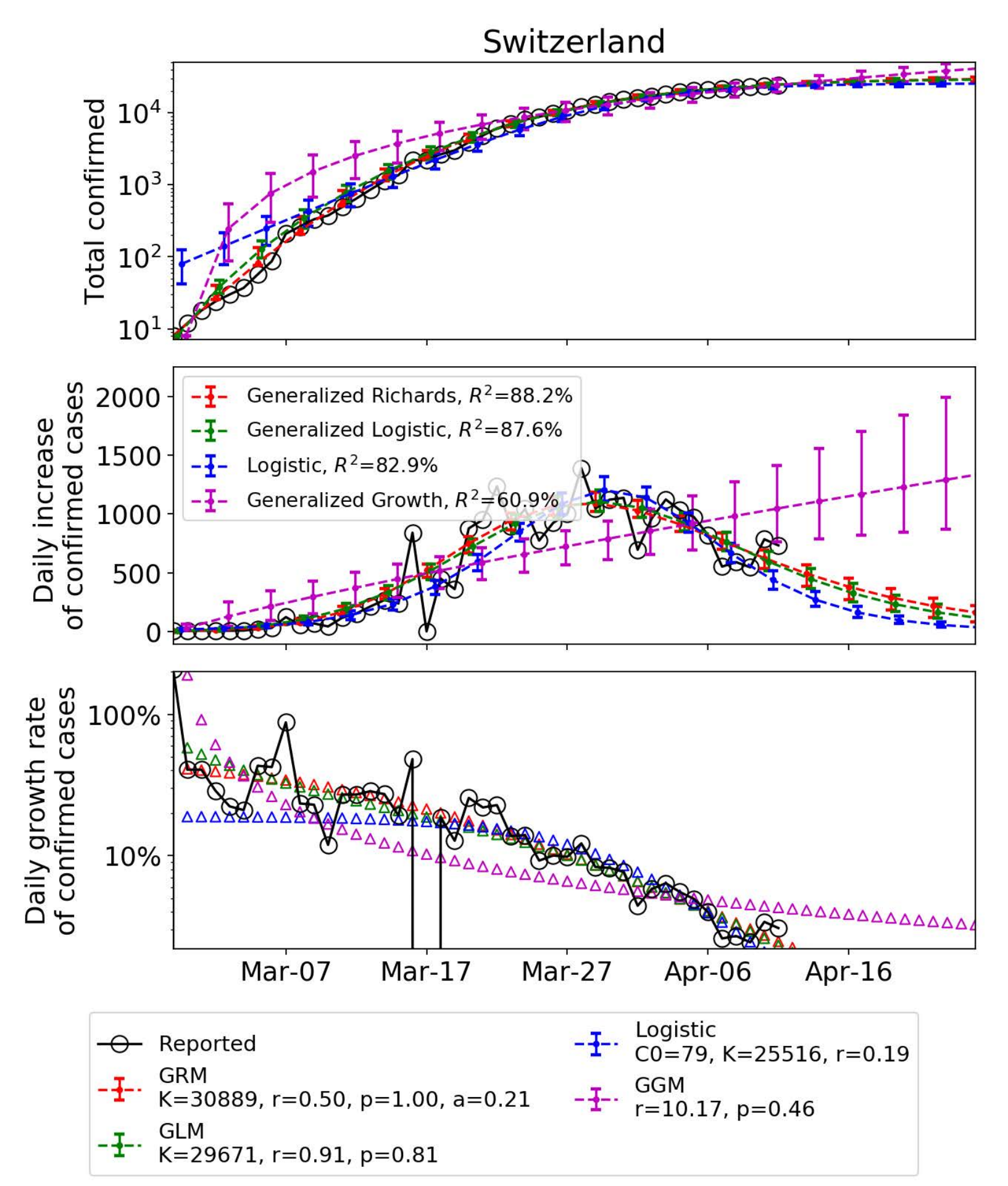

France
Total confirmed
10^5
10^4
10^3
10^2
Daily increase of confirmed cases
10000
7500
5000
2500
0
Generalized Richards, R^2=81.7%
Generalized Logistic, R^2=81.5%
Logistic, R^2=79.8%
Generalized Growth, R^2=73.2%
Daily growth rate of confirmed cases
100%
10%
Mar-05
Mar-15
Mar-25
Apr-04
Apr-14
Apr-24
Reported
GRM
K=135280, r=0.39, p=1.00, a=0.25
GLM
K=125199, r=0.79, p=0.84
Logistic
C0=169, K=104784, r=0.18
GGM
r=5.51, p=0.60

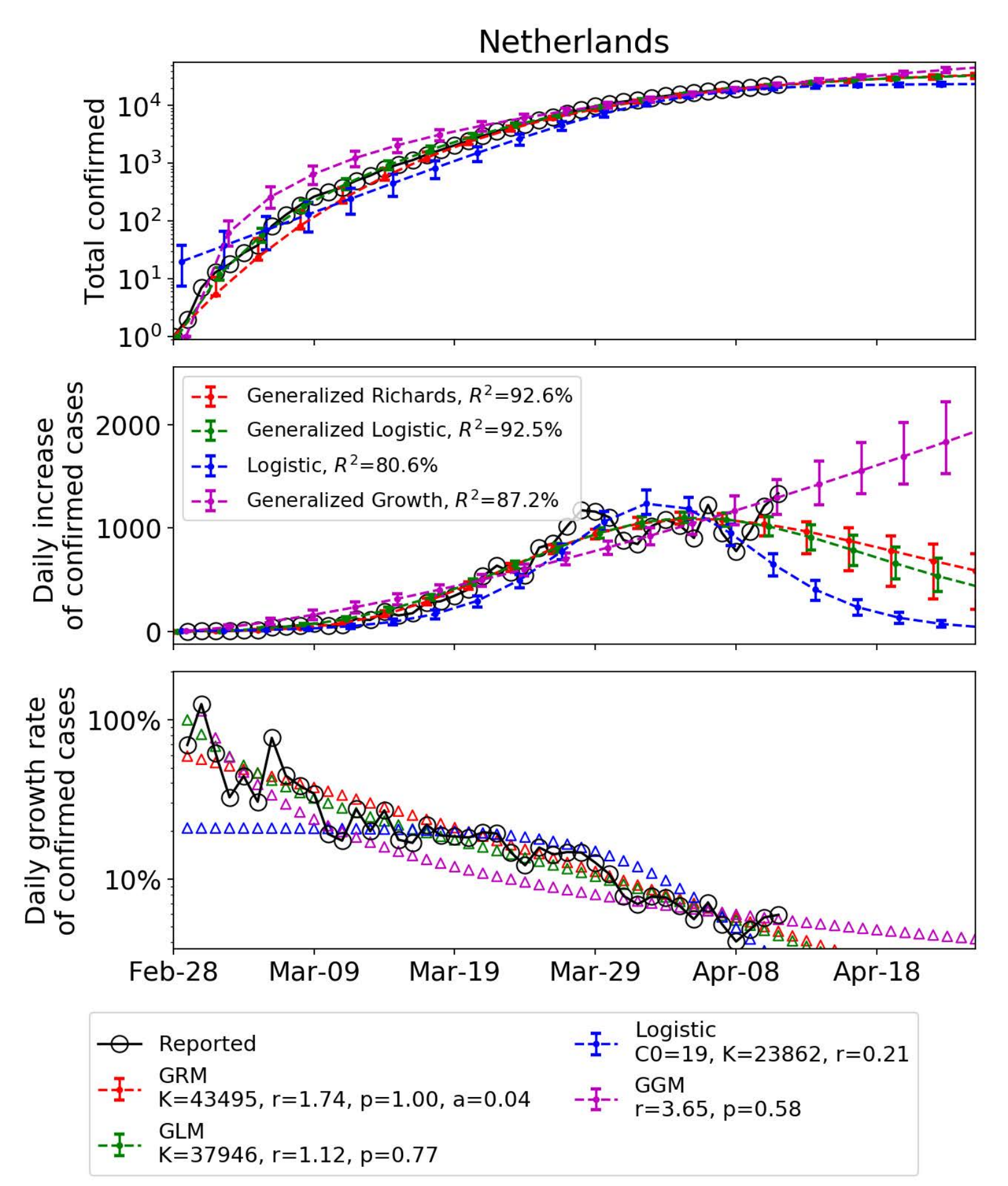

United Kingdom
Total confirmed
10^5
10^4
10^3
10^2
Daily increase of confirmed cases
15000
10000
5000
0
Generalized Richards, R^2=95.1%
Generalized Logistic, R^2=95.0%
Logistic, R^2=94.9%
Generalized Growth, R^2=91.8%
Daily growth rate of confirmed cases
100%
10%
Mar-01
Mar-11
Mar-21
Mar-31
Apr-10
Apr-20
Reported
GRM
K=137629, r=0.27, p=1.00, a=0.43
GLM
K=120865, r=0.41, p=0.91
Logistic
C0=116, K=112739, r=0.17
GGM
r=1.37, p=0.75

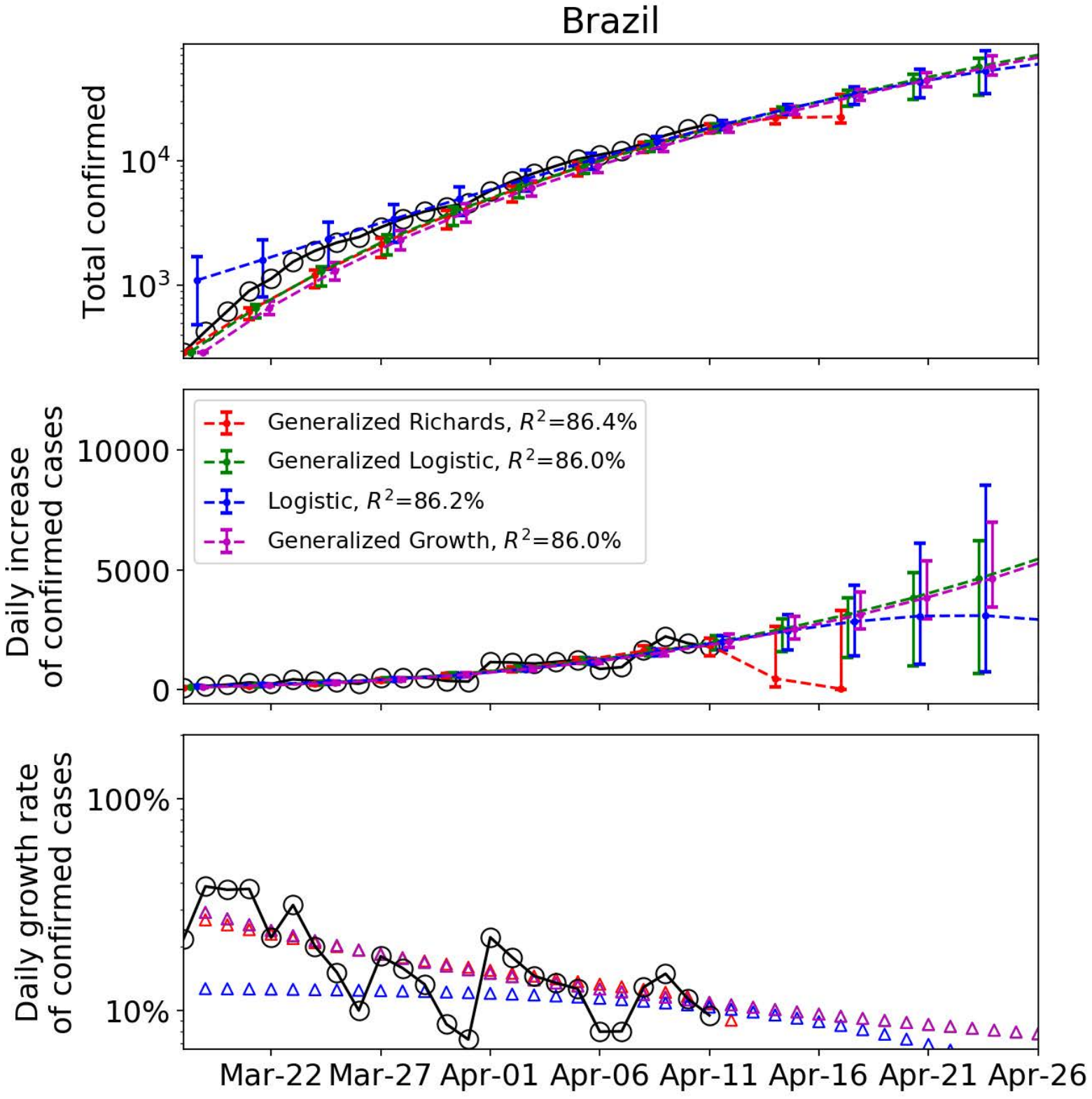

Iran
Total confirmed
10^5
10^4
10^3
10^2
10^1
Daily increase of confirmed cases
4000
3000
2000
1000
0
Generalized Richards, R^2=89.5%
Generalized Logistic, R^2=83.6%
Logistic, R^2=82.4%
Generalized Growth, R^2=77.9%
Daily growth rate of confirmed cases
100%
10%
Feb-20
Mar-01
Mar-11
Mar-21
Mar-31
Apr-10
Apr-20
Reported
GRM
K=72832, r=2.61, p=0.66, a=5.01
GLM
K=95623, r=1.06, p=0.79
Logistic
C0=49, K=68192, r=0.18
GGM
r=8.41, p=0.52

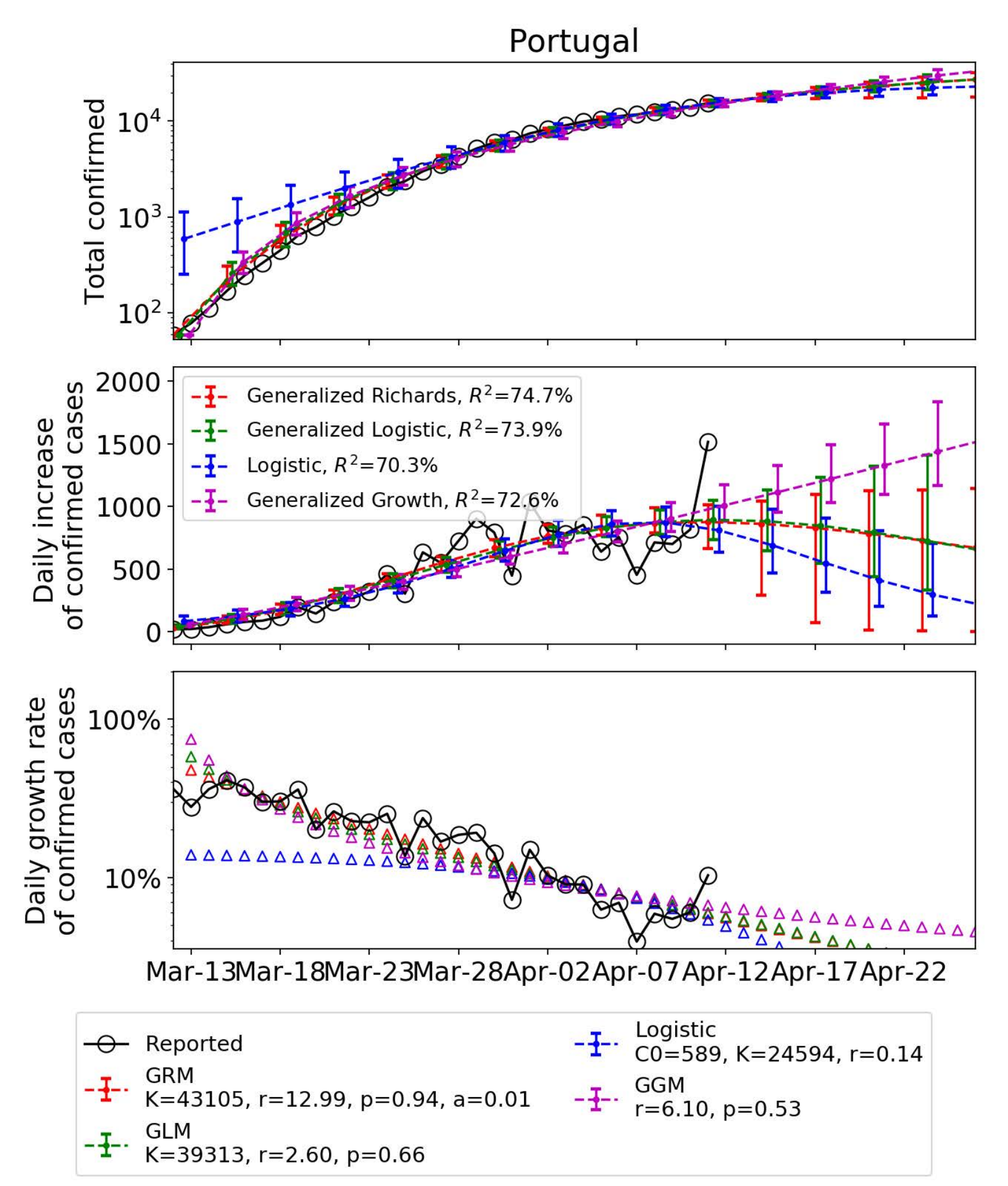

Turkey
Total confirmed
10^5
10^4
10^3
10^2
Daily increase of confirmed cases
10000
7500
5000
2500
0
Generalized Richards, R^2=96.7%
Generalized Logistic, R^2=96.6%
Logistic, R^2=90.7%
Generalized Growth, R^2=96.4%
Daily growth rate of confirmed cases
100%
10%
Mar-17
Mar-22
Mar-27
Apr-01
Apr-06
Apr-11
Apr-16
Apr-21
Apr-26
Reported
GRM
K=666590, r=5.33, p=0.85, a=0.03
GLM
K=290848, r=3.37, p=0.69
Logistic
C0=179, K=67420, r=0.25
GGM
r=4.54, p=0.65

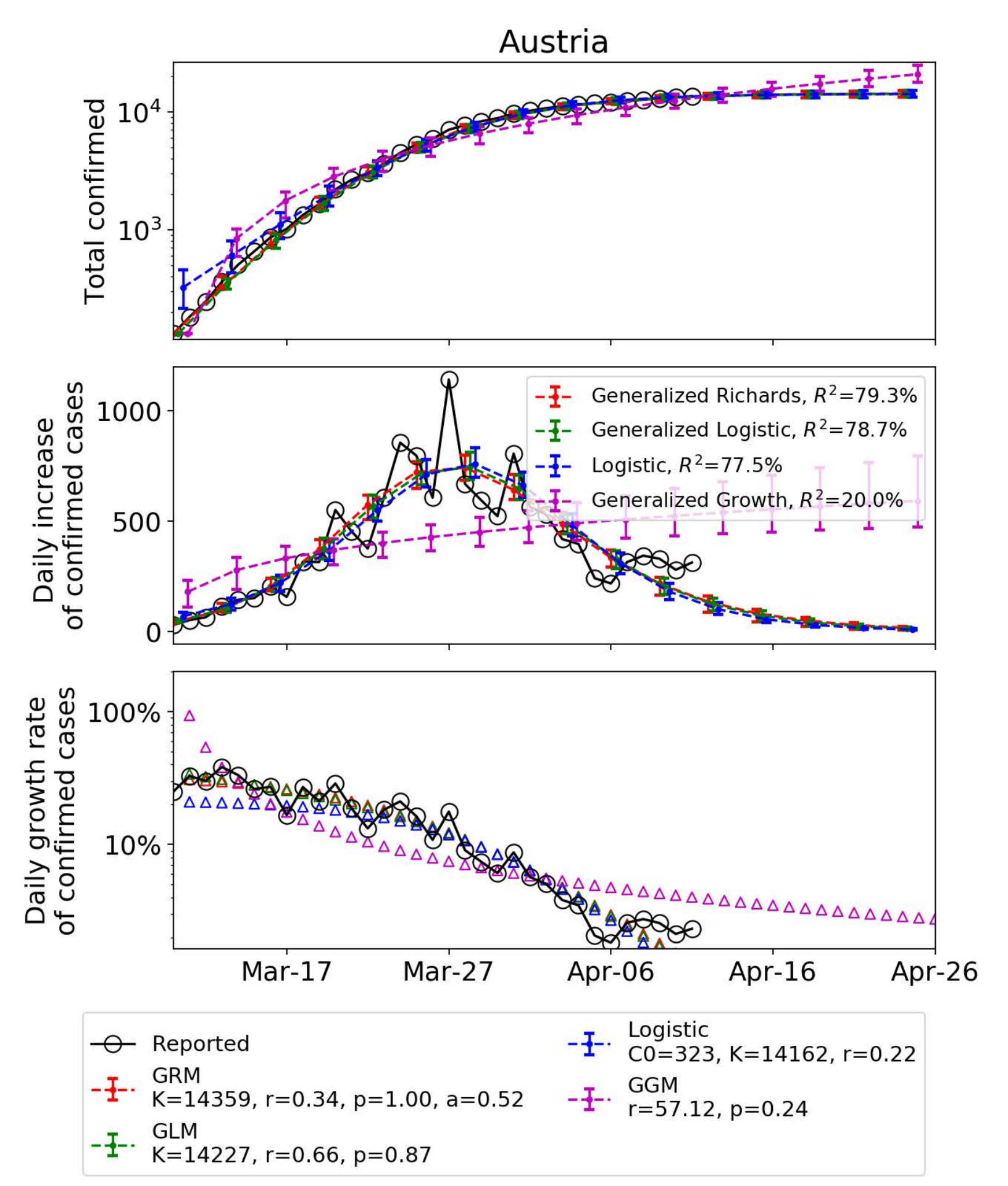

Belgium
Total confirmed
10^4
10^3
10^2
Daily increase of confirmed cases
3000
2000
1000
0
Generalized Richards, R^2=87.0%
Generalized Logistic, R^2=86.5%
Logistic, R^2=85.3%
Generalized Growth, R^2=81.5%
Daily growth rate of confirmed cases
100%
10%
Mar-05
Mar-15
Mar-25
Apr-04
Apr-14
Apr-24
Reported
GRM
K=48228, r=0.45, p=1.00, a=0.20
GLM
K=43412, r=0.83, p=0.82
Logistic
C0=229, K=37145, r=0.16
GGM
r=3.51, p=0.61

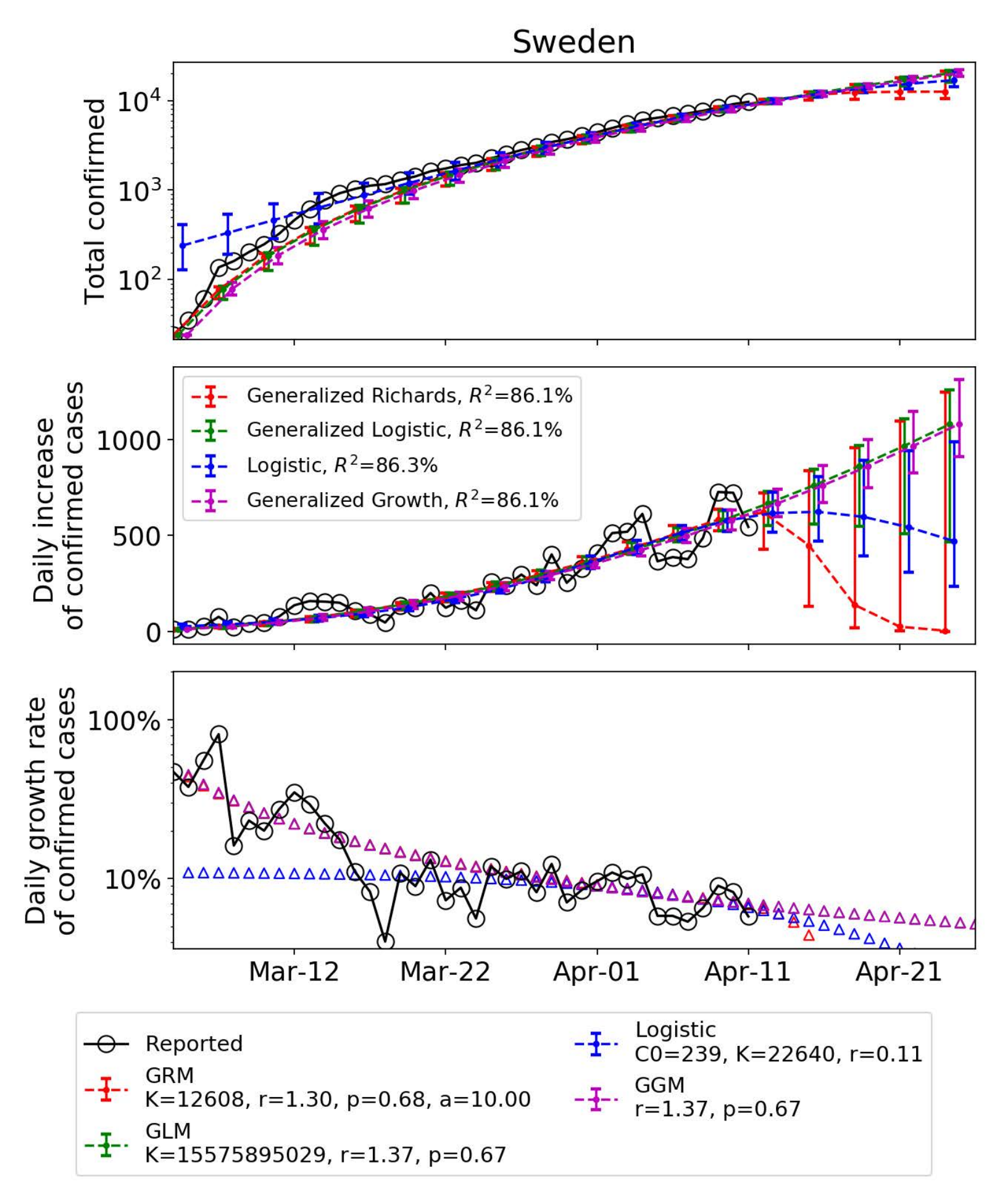

Switzerland
Total confirmed
10^4
10^3
10^2
10^1
Daily increase of confirmed cases
2000
1500
1000
500
0
Generalized Richards, R^2=88.2%
Generalized Logistic, R^2=87.6%
Logistic, R^2=82.9%
Generalized Growth, R^2=60.9%
Daily growth rate of confirmed cases
100%
10%
Mar-07
Mar-17
Mar-27
Apr-06
Apr-16
Reported
GRM
K=30889, r=0.50, p=1.00, a=0.21
GLM
K=29671, r=0.91, p=0.81
Logistic
C0=79, K=25516, r=0.19
GGM
r=10.17, p=0.46

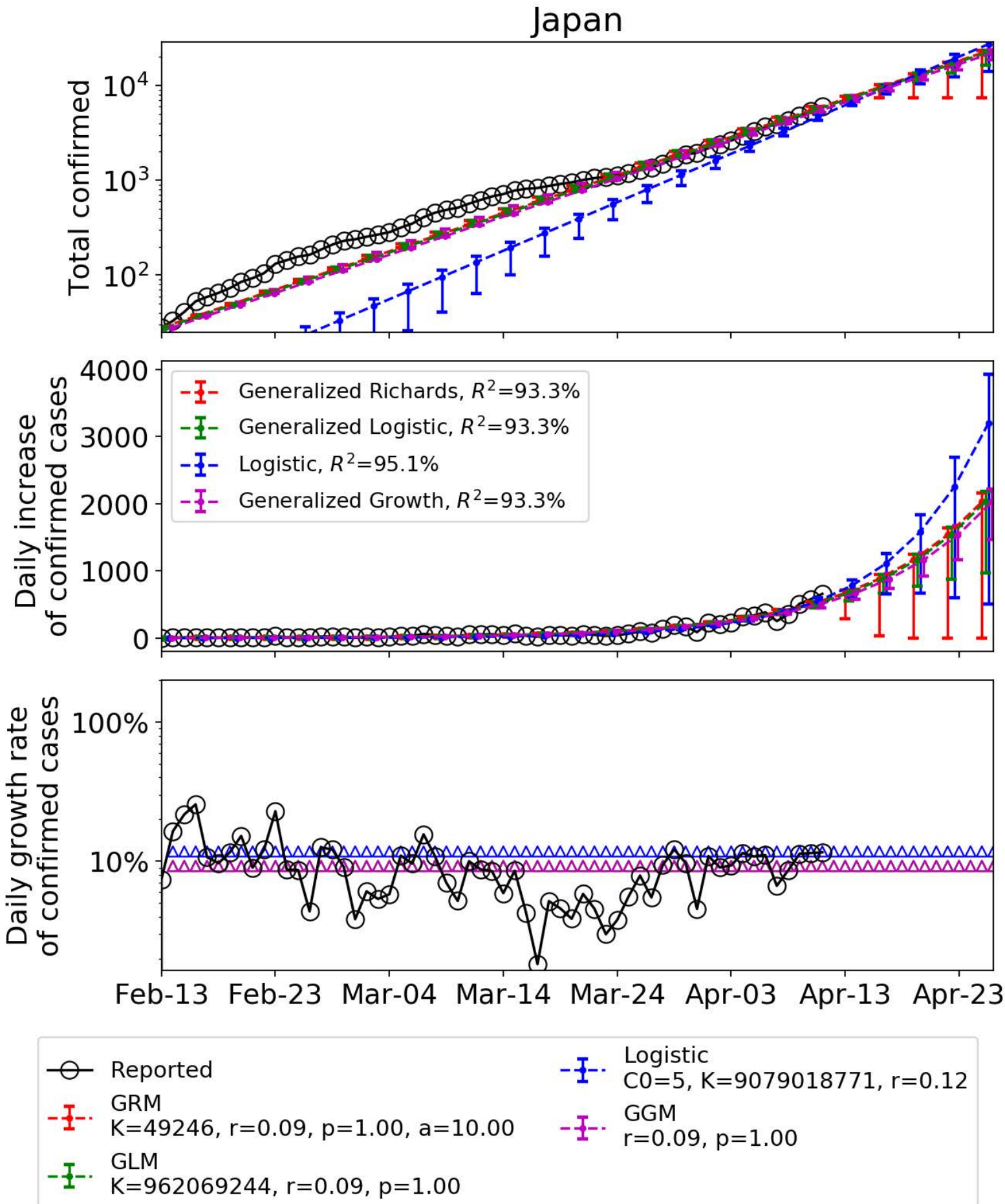

Netherlands
Total confirmed
10^4
10^3
10^2
10^1
10^0
Daily increase of confirmed cases
2000
1000
0
Generalized Richards, R^2=92.6%
Generalized Logistic, R^2=92.5%
Logistic, R^2=80.6%
Generalized Growth, R^2=87.2%
Daily growth rate of confirmed cases
100%
10%
Feb-28
Mar-09
Mar-19
Mar-29
Apr-08
Apr-18
Reported
GRM
K=43495, r=1.74, p=1.00, a=0.04
GLM
K=37946, r=1.12, p=0.77
Logistic
C0=19, K=23862, r=0.21
GGM
r=3.65, p=0.58


Brazil
Total confirmed
10^4
10^3
Daily increase of confirmed cases
10000
5000
0
Generalized Richards, R^2=86.4%
Generalized Logistic, R^2=86.0%
Logistic, R^2=86.2%
Generalized Growth, R^2=86.0%
Daily growth rate of confirmed cases
100%
10%
Mar-22
Mar-27
Apr-01
Apr-06
Apr-11
Apr-16
Apr-21
Apr-26
Reported
GRM
K=22448, r=0.91, p=0.79, a=10.00
GLM
K=22737762710, r=1.23, p=0.75
Logistic
C0=1096, K=96451, r=0.13
GGM
r=1.23, p=0.75


Portugal
Total confirmed
10^4
10^3
10^2
Daily increase of confirmed cases
2000
1500
1000
500
0
Generalized Richards, R^2=74.7%
Generalized Logistic, R^2=73.9%
Logistic, R^2=70.3%
Generalized Growth, R^2=72.6%
Daily growth rate of confirmed cases
100%
10%
Mar-13
Mar-18
Mar-23
Mar-28
Apr-02
Apr-07
Apr-12
Apr-17
Apr-22
Reported
GRM
K=43105, r=12.99, p=0.94, a=0.01
GLM
K=39313, r=2.60, p=0.66
Logistic
C0=589, K=24594, r=0.14
GGM
r=6.10, p=0.53


Austria
Total confirmed
10^4
10^3
Daily increase of confirmed cases
1000
500
0
Generalized Richards, R^2=79.3%
Generalized Logistic, R^2=78.7%
Logistic, R^2=77.5%
Generalized Growth, R^2=20.0%
Daily growth rate of confirmed cases
100%
10%
Mar-17
Mar-27
Apr-06
Apr-16
Apr-26
Reported
GRM
K=14359, r=0.34, p=1.00, a=0.52
GLM
K=14227, r=0.66, p=0.87
Logistic
C0=323, K=14162, r=0.22
GGM
r=57.12, p=0.24


Sweden
Total confirmed
10^4
10^3
10^2
Daily increase of confirmed cases
1000
500
0
Generalized Richards, R^2=86.1%
Generalized Logistic, R^2=86.1%
Logistic, R^2=86.3%
Generalized Growth, R^2=86.1%
Daily growth rate of confirmed cases
100%
10%
Mar-12
Mar-22
Apr-01
Apr-11
Apr-21
Reported
GRM
K=12608, r=1.30, p=0.68, a=10.00
GLM
K=15575895029, r=1.37, p=0.67
Logistic
C0=239, K=22640, r=0.11
GGM
r=1.37, p=0.67


Japan
Total confirmed
10^4
10^3
10^2
Daily increase of confirmed cases
4000
3000
2000
1000
0
Generalized Richards, R^2=93.3%
Generalized Logistic, R^2=93.3%
Logistic, R^2=95.1%
Generalized Growth, R^2=93.3%
Daily growth rate of confirmed cases
100%
10%
Feb-13
Feb-23
Mar-04
Mar-14
Mar-24
Apr-03
Apr-13
Apr-23
Reported
GRM
K=49246, r=0.09, p=1.00, a=10.00
GLM
K=962069244, r=0.09, p=1.00
Logistic
C0=5, K=9079018771, r=0.12
GGM
r=0.09, p=1.00