

COVID19 Time Series Analysis, Worldwide and U.S.

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29 March 2020

Source data: 2019 Novel Coronavirus COVID-19 (2019-nCoV) Data Repository by Johns Hopkins CSSE;
<https://github.com/CSSEGISandData/COVID-19>

Source code: <https://github.com/opencedar/covid19>

The visualizations in this document are heavily indebted to Edward Tufte and his use of sparklines—small, clutter-free time series lines—to show how many different panels or categories of data are changing through time; check out https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001OR.

Worldwide

Worldwide Summary

Sorted by total number of cases. Percent growth in total cases in the past seven days is last column.

Table 1: Worldwide Summary

Country_Region	days_50	conf	deaths	new_conf	conf_lag7	l7_rate
US	34	121478	2026	19821	25493	376%
Italy	36	92472	10023	5974	53578	72%
China	67	81999	3299	102	81305	0%
Spain	28	73235	5982	7516	25374	188%
Germany	29	57695	433	6824	22213	160%
France	30	38105	2317	4703	14308	168%
Iran	34	35408	2517	3076	20610	72%
United Kingdom	18	17312	1021	2567	5067	240%
Switzerland	26	14076	264	1148	6575	116%
Netherlands	24	9819	640	1172	3640	168%
Korea, South	38	9478	144	146	8799	8%
Belgium	24	9134	353	1850	2815	224%
Austria	23	8271	68	614	2814	192%
Turkey	11	7402	108	1704	670	1,004%
Canada	22	5576	61	894	1278	336%
Portugal	18	5170	100	902	1280	304%
Norway	25	4015	23	260	2118	88%
Brazil	17	3904	111	487	1021	284%
Australia	25	3640	14	497	1071	240%
Israel	19	3619	12	584	883	308%
Sweden	24	3447	105	378	1763	96%
Czechia	18	2631	11	352	995	164%
Ireland	16	2415	36	294	785	208%
Denmark	20	2366	65	166	1420	68%
Malaysia	25	2320	27	159	1183	96%
Chile	15	1909	6	299	537	256%
Luxembourg	15	1831	18	226	670	172%
Ecuador	12	1823	48	228	506	260%
Japan	42	1693	52	225	1007	68%

Country_Region	days_50	conf	deaths	new_conf	conf_lag7	l7_rate
Poland	16	1638	18	249	536	204%
Pakistan	14	1495	12	122	730	104%
Romania	16	1452	37	160	367	296%
Russia	15	1264	4	228	306	312%
Thailand	22	1245	6	109	411	204%
Saudi Arabia	16	1203	4	99	392	208%
South Africa	14	1187	1	17	240	396%
Finland	18	1167	9	126	523	124%
Indonesia	16	1155	102	109	450	156%
Philippines	17	1075	68	272	307	252%
Greece	21	1061	32	95	530	100%
World	23	636185	30177	64754	294570	116%

Ln (Seven-Day-Moving-Average New Cases) Impact on Ln (New Cases)

In other words, elasticity. How does this elasticity change through time, from days since the 50th case?

An elasticity under 1 indicates that over a seven-day period, new cases are decreasing.

The black line shows the best curve fit for elasticity changing over time. All countries generally are moving to cap the rate of exponential growth. Countries above the line are doing worse than average, and those below the line are doing better than average. A rate below 1 indicates that new cases are declining over an average 7-day period.

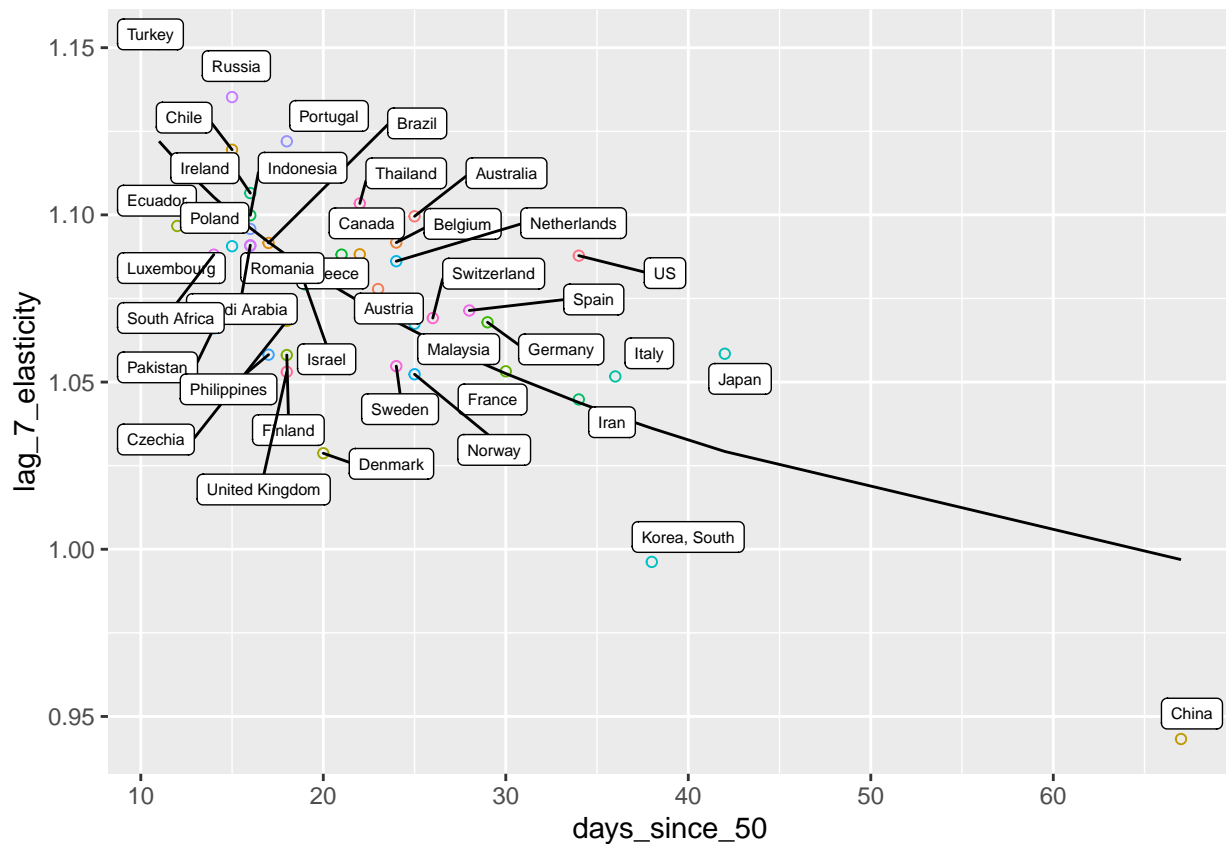


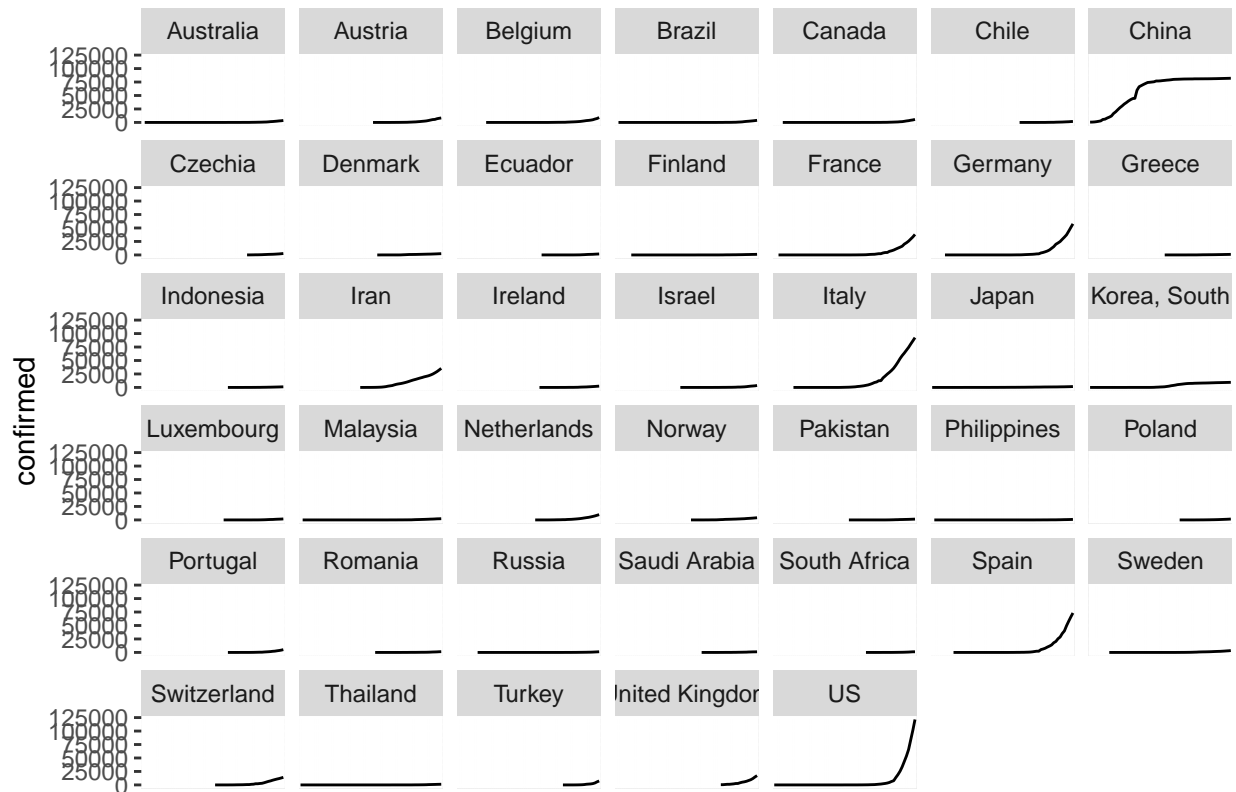
Table 2: Countries by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

country	days_since_50	lag_7_elasticity	prediction	residual
Turkey	11	1.15	1.12	0.03
Ecuador	12	1.10	1.12	-0.02
Pakistan	14	1.07	1.11	-0.04
South Africa	14	1.09	1.11	-0.02
Luxembourg	15	1.09	1.10	-0.01
Chile	15	1.12	1.10	0.02
Russia	15	1.14	1.10	0.03
Romania	16	1.09	1.10	-0.01
Saudi Arabia	16	1.09	1.10	-0.01
Poland	16	1.10	1.10	0.00
Indonesia	16	1.10	1.10	0.00
Ireland	16	1.11	1.10	0.01
Philippines	17	1.06	1.09	-0.03
Brazil	17	1.09	1.09	0.00
United Kingdom	18	1.05	1.09	-0.03
Finland	18	1.06	1.09	-0.03
Czechia	18	1.07	1.09	-0.02
Portugal	18	1.12	1.09	0.03
Israel	19	1.08	1.08	0.00
Denmark	20	1.03	1.08	-0.05
Greece	21	1.09	1.08	0.01
Canada	22	1.09	1.07	0.01
Thailand	22	1.10	1.07	0.03
Austria	23	1.08	1.07	0.01
Sweden	24	1.05	1.07	-0.01
Netherlands	24	1.09	1.07	0.02
Belgium	24	1.09	1.07	0.02
Norway	25	1.05	1.07	-0.01
Malaysia	25	1.07	1.07	0.00
Australia	25	1.10	1.07	0.03
Switzerland	26	1.07	1.06	0.01
Spain	28	1.07	1.06	0.01
Germany	29	1.07	1.05	0.01
France	30	1.05	1.05	0.00
Iran	34	1.04	1.04	0.00
US	34	1.09	1.04	0.04
Italy	36	1.05	1.04	0.01
Korea, South	38	1.00	1.04	-0.04
Japan	42	1.06	1.03	0.03
China	67	0.94	1.00	-0.05

Sparklines

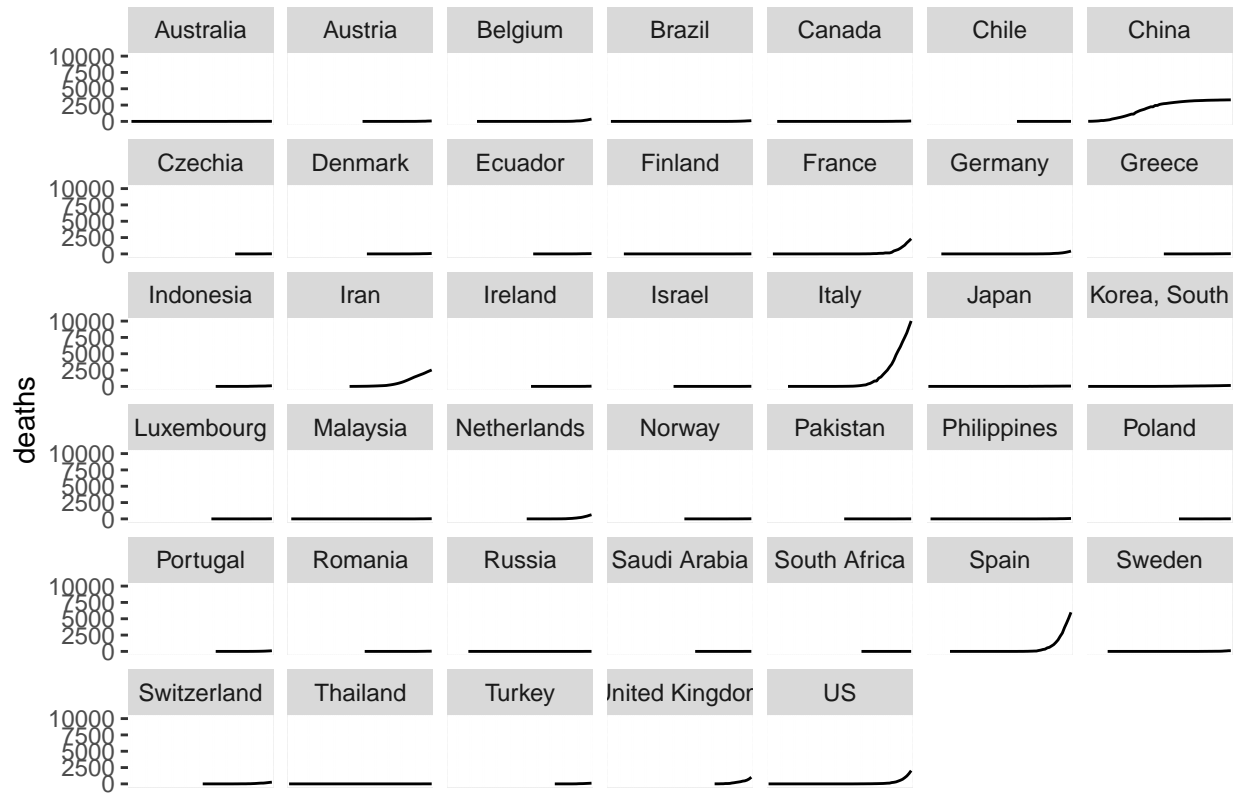
Confirmed Cases

Confirmed COVID19 Cases Through 29 March 2020



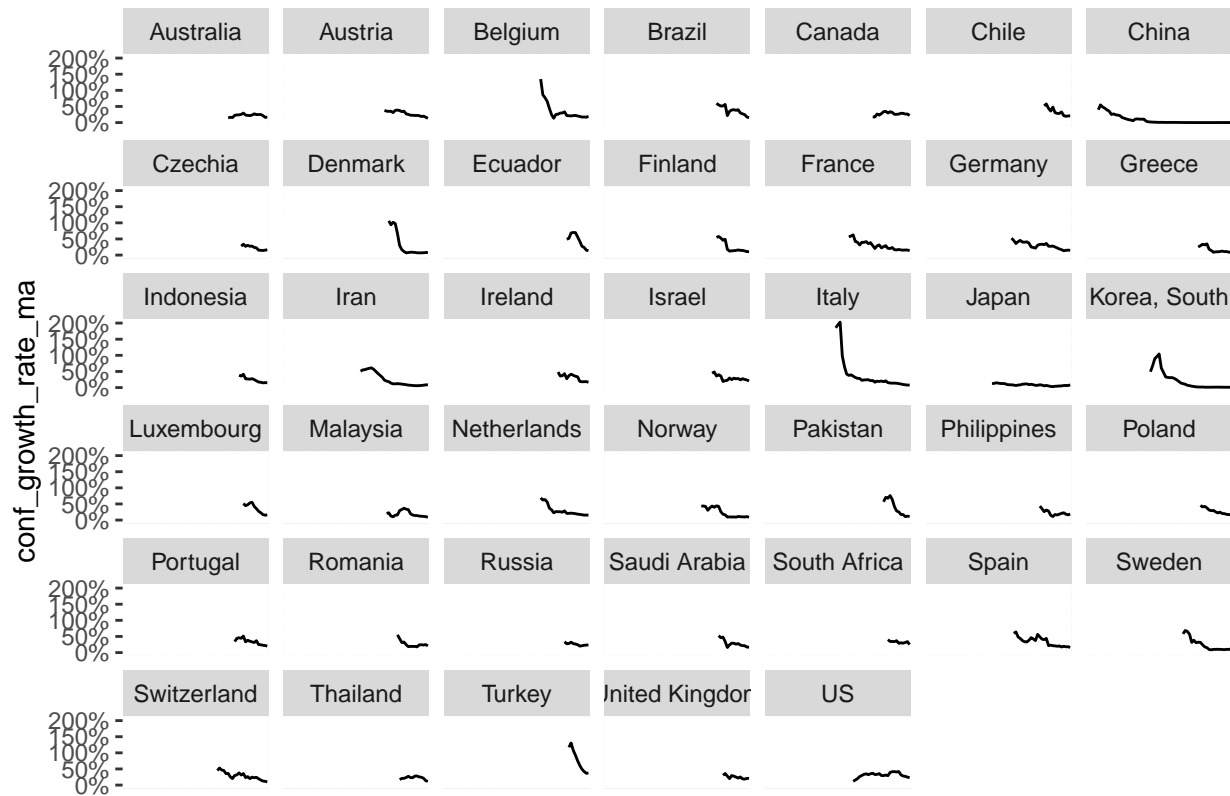
Deaths

Cumulative COVID19 Deaths Through 29 March 2020



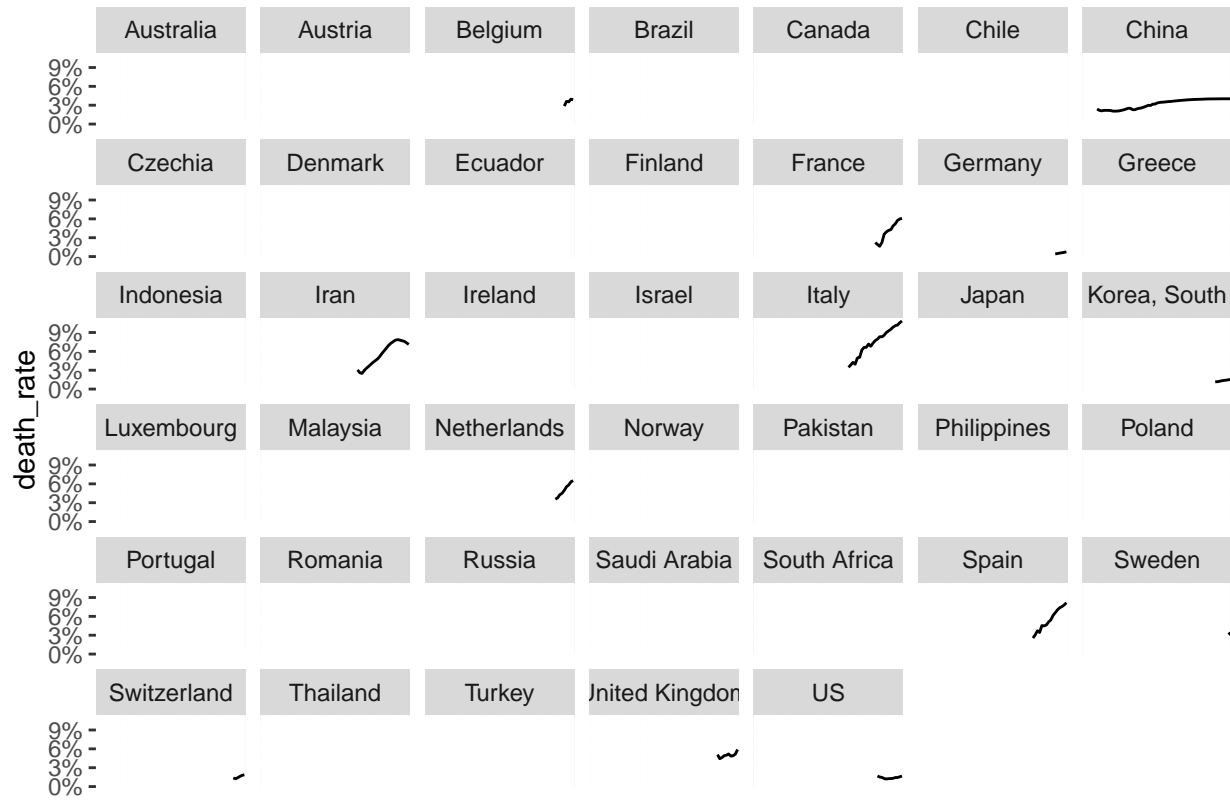
Confirmed Growth Rate 5-Day Moving Average

5-Day MA Confirmed Growth Rate Through 29 March 2020



Death Rate

Death Rate Through 29 March 2020



U.S. Analysis

State Summary

Sorted by total number of cases. Percent growth in total cases in the past seven days is last column.

Table 3: State-by-State Summary

Province_State	days_50	conf	deaths	new_conf	conf_lag7	17_rate
New York	22	52410	728	7534	11710	348%
New Jersey	15	11124	140	2299	1327	740%
California	24	5095	110	438	1364	272%
Michigan	13	4650	111	1016	788	492%
Massachusetts	19	4257	44	1017	525	712%
Washington	24	4030	188	553	1793	124%
Florida	16	3763	54	863	659	472%
Illinois	15	3491	47	467	753	364%
Louisiana	15	3315	137	571	585	468%
Pennsylvania	14	2845	34	500	396	620%
Texas	15	2455	30	518	581	324%
Georgia	15	2366	69	366	507	368%
Colorado	15	1740	31	307	390	348%
Connecticut	12	1524	33	233	194	684%
Tennessee	13	1511	7	193	371	308%
Ohio	13	1406	25	269	248	468%

Province_State	days_50	conf	deaths	new_conf	conf_lag7	l7_rate
Indiana	10	1233	31	254	128	864%
Wisconsin	12	1055	17	129	282	276%
North Carolina	12	1020	5	133	253	304%
Maryland	12	995	5	220	193	416%
Missouri	9	836	10	170	74	1,028%
Arizona	9	773	15	108	118	556%
Virginia	12	740	13	133	156	376%
Alabama	10	694	4	107	131	428%
Mississippi	10	663	13	84	140	372%
South Carolina	10	660	15	118	171	284%
Nevada	12	626	10	90	161	288%
Utah	12	602	1	130	136	344%
Oregon	12	479	13	63	114	320%
Minnesota	13	441	5	45	138	220%
Arkansas	10	409	5	28	122	236%
Kentucky	8	393	9	92	87	352%
Oklahoma	8	377	15	55	53	612%
District of Columbia	9	304	4	33	77	296%
Iowa	8	298	3	63	68	340%
Kansas	8	266	4	60	57	368%
Rhode Island	9	239	2	36	66	264%
Idaho	6	234	4	29	36	552%
Delaware	7	214	5	51	45	376%
Maine	10	211	1	43	70	200%
Vermont	7	211	12	27	29	628%
New Mexico	7	208	1	72	43	384%
New Hampshire	8	187	2	29	55	240%
Hawaii	7	149	0	43	37	304%
Montana	5	129	1	20	21	516%
Grand Princess	1	103	3	75	23	348%
Puerto Rico	4	100	3	21	21	376%
US	11	120831	2019	19705	25296	376%

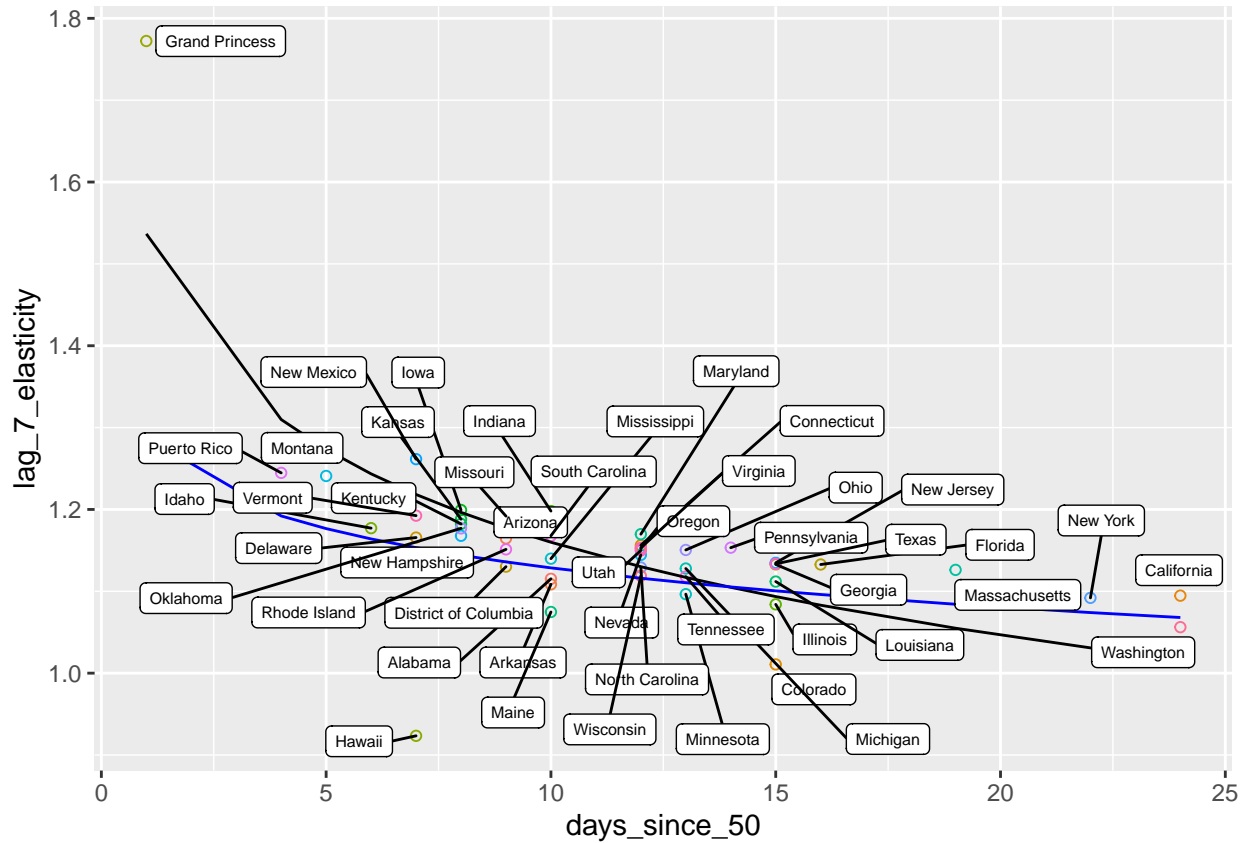
Ln (Seven-Day-Moving-Average New Cases) Impact on Ln (New Cases)

In other words, elasticity. How does this elasticity change through time, from days since the 50th case?

An elasticity under 1 indicates that over a seven-day period, new cases are decreasing.

The black line is the best fit for elasticity for the states that have had 50 cases as they progress. Above the line: worse than average; below-the-line: better than average.

The blue line is the best fit for elasticity for countries across the world. It's apparent that the U.S. is not doing as well as the rest of the world in containing exponential growth—probably due to initial testing failures.



Comparisons with U.S. and worldwide averages

Some states are doing better than worldwide averages when taking into account days since 50th case. Most are doing worse.

Table 4: States by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

state	days_since_50	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
Grand Princess	1	1.77	1.54	1.29	0.24	0.48
Puerto Rico	4	1.24	1.31	1.19	-0.07	0.05
Montana	5	1.24	1.27	1.18	-0.03	0.06
Idaho	6	1.18	1.24	1.16	-0.07	0.01
Hawaii	7	0.92	1.22	1.15	-0.29	-0.23
Delaware	7	1.17	1.22	1.15	-0.05	0.01
Vermont	7	1.19	1.22	1.15	-0.03	0.04
New Mexico	7	1.26	1.22	1.15	0.04	0.11
New Hampshire	8	1.17	1.20	1.14	-0.03	0.02
Oklahoma	8	1.18	1.20	1.14	-0.02	0.03
Kentucky	8	1.18	1.20	1.14	-0.01	0.04
Kansas	8	1.19	1.20	1.14	-0.01	0.04
Iowa	8	1.20	1.20	1.14	0.00	0.06
District of Columbia	9	1.13	1.18	1.14	-0.05	-0.01
Rhode Island	9	1.15	1.18	1.14	-0.03	0.02
Arizona	9	1.16	1.18	1.14	-0.01	0.03
Missouri	9	1.19	1.18	1.14	0.01	0.06
Maine	10	1.07	1.16	1.13	-0.09	-0.05

state	days_since_50	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
Arkansas	10	1.11	1.16	1.13	-0.05	-0.02
Alabama	10	1.12	1.16	1.13	-0.04	-0.01
Mississippi	10	1.14	1.16	1.13	-0.02	0.01
South Carolina	10	1.17	1.16	1.13	0.01	0.04
Indiana	10	1.20	1.16	1.13	0.04	0.07
Wisconsin	12	1.12	1.13	1.12	-0.01	0.00
North Carolina	12	1.13	1.13	1.12	0.00	0.01
Nevada	12	1.14	1.13	1.12	0.01	0.03
Utah	12	1.15	1.13	1.12	0.02	0.03
Oregon	12	1.15	1.13	1.12	0.02	0.04
Virginia	12	1.15	1.13	1.12	0.02	0.04
Connecticut	12	1.16	1.13	1.12	0.03	0.04
Maryland	12	1.17	1.13	1.12	0.04	0.05
Minnesota	13	1.10	1.12	1.11	-0.02	-0.01
Tennessee	13	1.12	1.12	1.11	0.00	0.01
Michigan	13	1.13	1.12	1.11	0.01	0.02
Ohio	13	1.15	1.12	1.11	0.03	0.04
Pennsylvania	14	1.15	1.10	1.11	0.05	0.05
Colorado	15	1.01	1.09	1.10	-0.08	-0.09
Illinois	15	1.08	1.09	1.10	-0.01	-0.02
Louisiana	15	1.11	1.09	1.10	0.02	0.01
Georgia	15	1.13	1.09	1.10	0.04	0.03
Texas	15	1.13	1.09	1.10	0.04	0.03
New Jersey	15	1.13	1.09	1.10	0.04	0.03
Florida	16	1.13	1.08	1.10	0.05	0.04
Massachusetts	19	1.13	1.05	1.08	0.07	0.04
New York	22	1.09	1.03	1.07	0.06	0.02
Washington	24	1.06	1.02	1.07	0.04	-0.01
California	24	1.09	1.02	1.07	0.08	0.03

Forecast New Cases by State

We estimate new cases by date, to see when states will peak, based on the worldwide curve fit. The reasoning is that testing rates increasing wildly recently in the U.S. have falsely inflated elasticity.

Table 5: Forecast Peak New Cases by State

state	total_cases	peak_new_cases	date	population	perc_pop_infected
Minnesota	1,448	67	2020-03-23	5,420,380	0.0%
Alabama	2,553	139	2020-03-25	4,833,722	0.1%
Arkansas	1,324	61	2020-03-25	2,959,373	0.0%
California	20,394	901	2020-03-26	38,332,521	0.1%
Colorado	3,272	409	2020-03-26	5,268,367	0.1%
Illinois	10,018	673	2020-03-26	12,882,135	0.1%
Washington	9,129	616	2020-03-26	6,971,406	0.1%
Oregon	2,868	100	2020-03-27	3,930,065	0.1%
Wisconsin	3,960	198	2020-03-27	5,742,713	0.1%
Maine	665	43	2020-03-28	1,328,302	0.1%
Utah	3,523	130	2020-03-28	2,900,872	0.1%
North Carolina	4,409	172	2020-03-31	9,848,060	0.0%
Louisiana	13,655	589	2020-04-01	4,625,470	0.3%
Mississippi	2,909	113	2020-04-02	2,991,207	0.1%

state	total_cases	peak_new_cases	date	population	perc_pop_infected
Nevada	3,380	122	2020-04-02	2,790,136	0.1%
New York	184,830	8,315	2020-04-02	19,651,127	0.9%
Tennessee	5,775	230	2020-04-02	6,495,978	0.1%
Georgia	13,564	535	2020-04-03	9,992,167	0.1%
Michigan	22,522	1,038	2020-04-03	9,895,622	0.2%
Ohio	9,732	367	2020-04-03	11,570,808	0.1%
South Carolina	3,950	145	2020-04-03	4,774,839	0.1%
Virginia	4,690	170	2020-04-03	8,260,405	0.1%
Florida	24,307	982	2020-04-04	19,552,860	0.1%
New Jersey	76,957	3,441	2020-04-04	8,899,339	0.9%
Texas	14,503	575	2020-04-04	26,448,193	0.1%
Connecticut	10,851	426	2020-04-05	3,596,080	0.3%
Massachusetts	32,341	1,253	2020-04-06	6,692,824	0.5%
Pennsylvania	25,277	1,008	2020-04-07	12,773,801	0.2%
Maryland	9,125	337	2020-04-08	5,928,814	0.2%
Indiana	17,983	713	2020-04-09	6,570,902	0.3%

Forecast New Cases U.S. Total

U.S. Confirmed COVID19 Case Forecast as of 29 March 2020

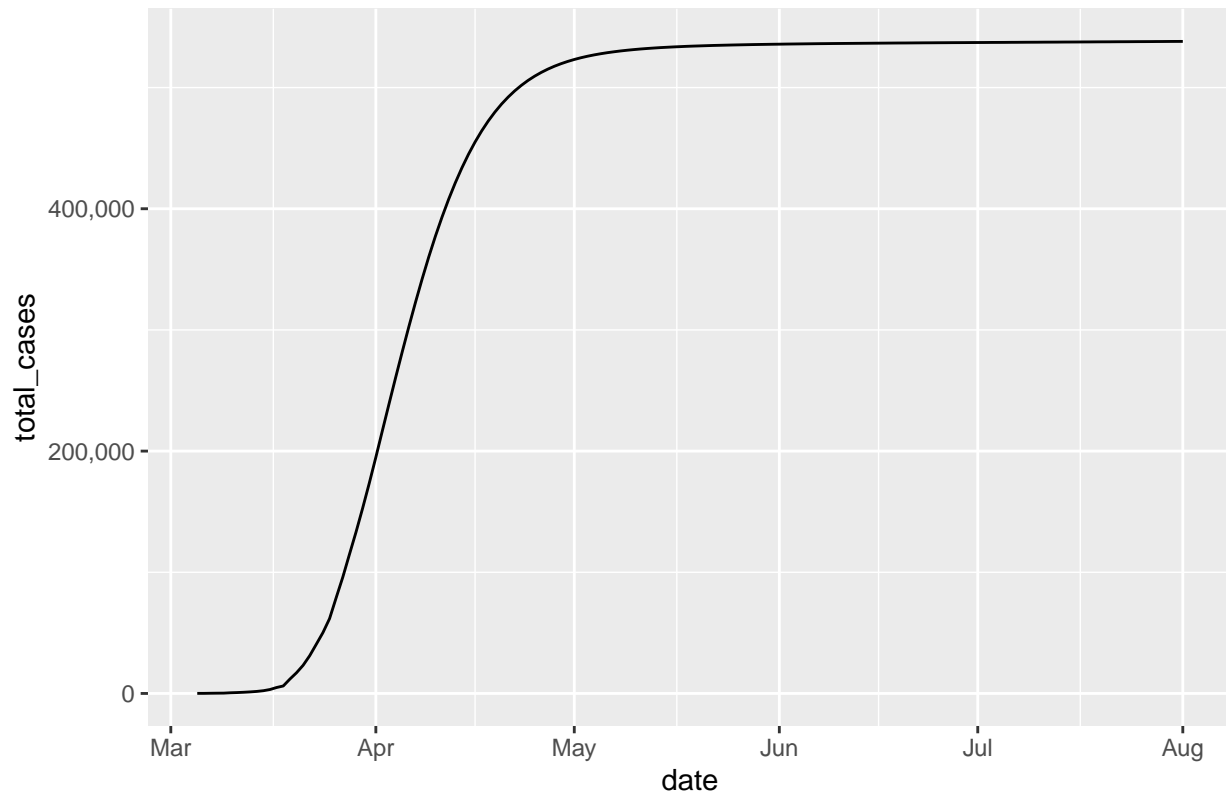
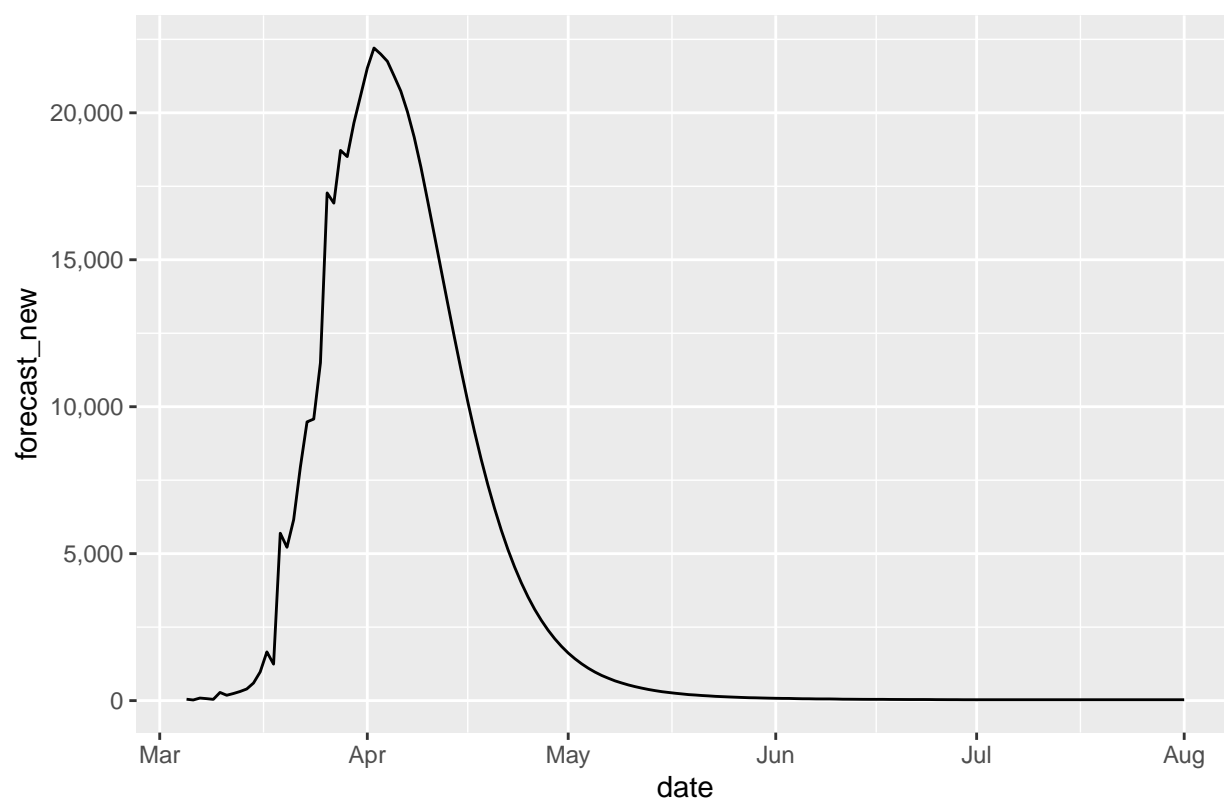


Table 6: Peak New Cases in U.S.

date	forecast_new	total_cases
2020-04-02	22,205	217,118

U.S. New COVID19 Case Forecast as of 29 March 2020



Sparklines

We only look at states with more than one hundred cases today. For moving average growth rates, we only look at states with deaths and recoveries over 25.

Confirmed Cases

Confirmed COVID19 Cases Through 29 March 2020



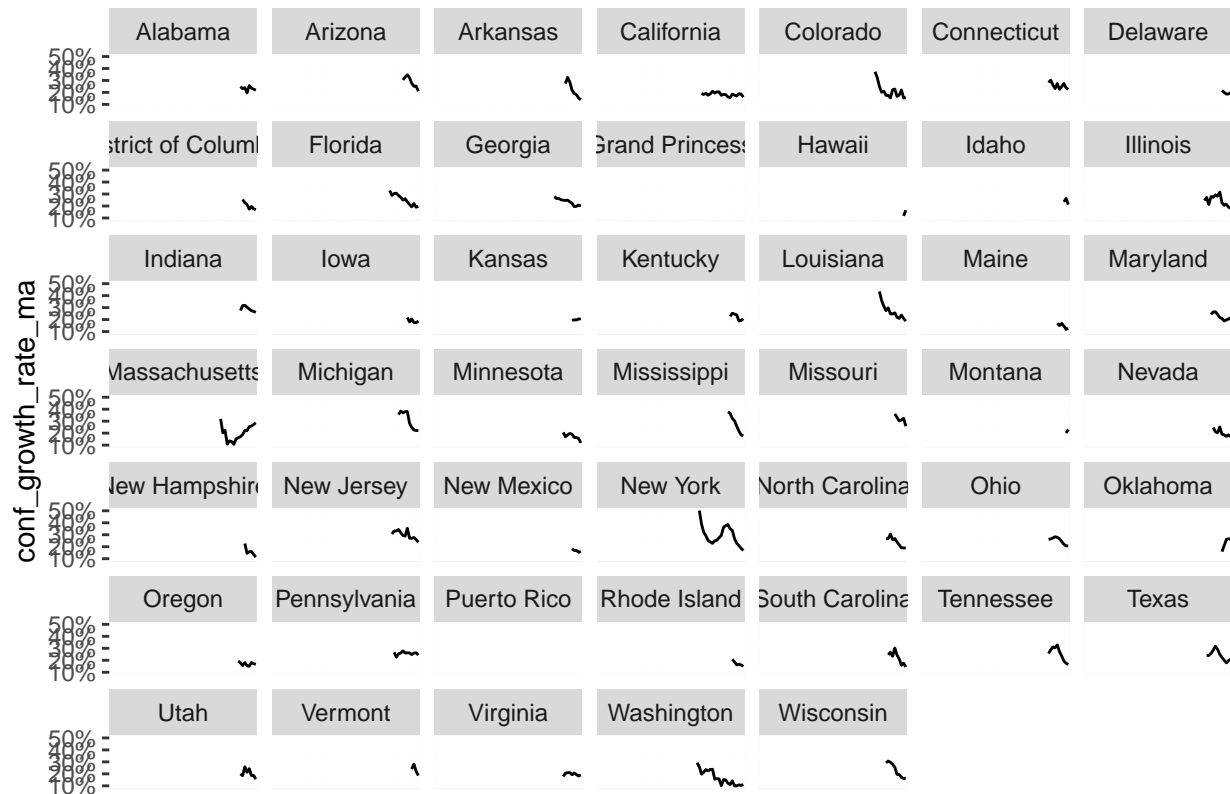
Deaths

Cumulative COVID19 Deaths Through 29 March 2020



Confirmed Growth Rate 5-Day Moving Average

Confirmed Growth Rate Through 29–1 March 2020



Death Rate 5-Day Moving Average

Only states with >25 deaths are shown

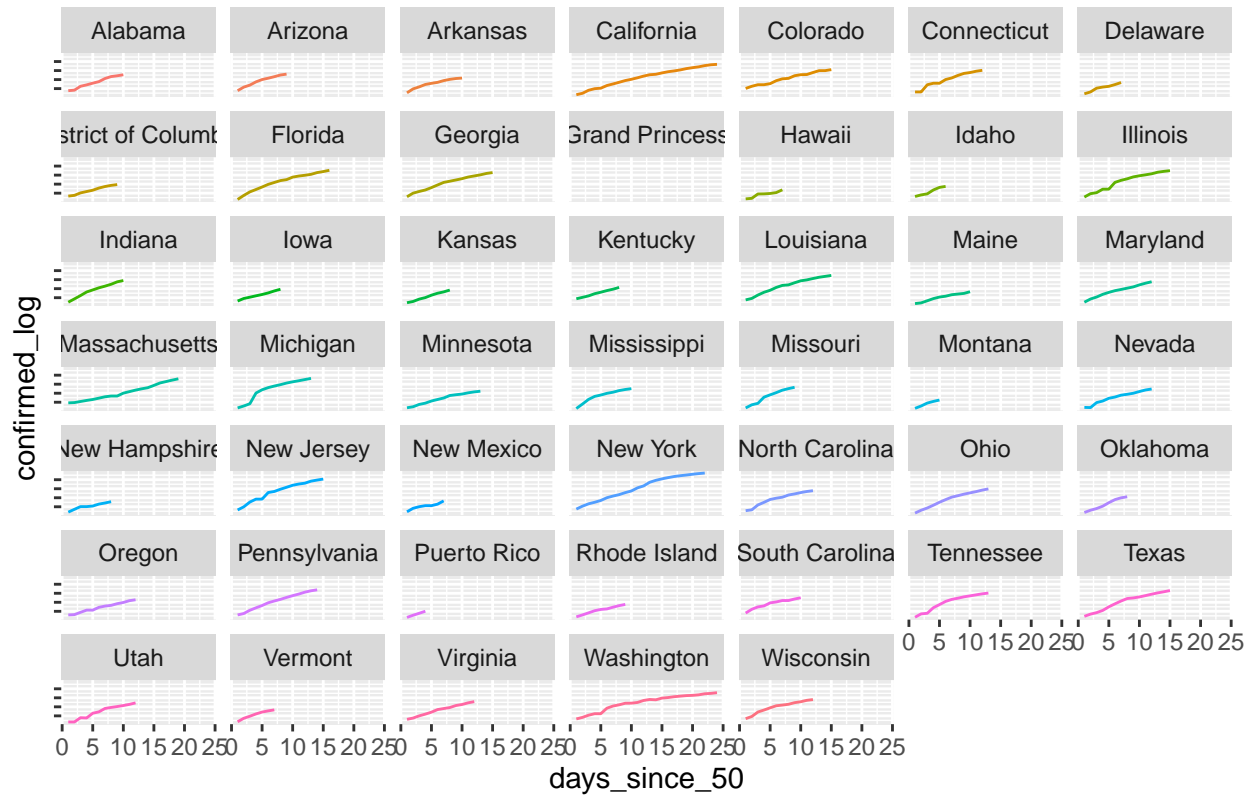
Death Rate Through 29–1 March 2020



Log / Time for States After 50th Case

Log-10 by States: Confirmed Cases by Day After 50th Confirmed Case

Log-10 of Confirmed Cases Since 50th Case by State as of 29 March 2020



Zero at Fifty Cases

Confirmed Cases

Confirmed COVID19 Cases by State Through 29 March 2020

