COVID19 Time Series Analysis, Worldwide and U.S.

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30 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	35	140886	2467	19408	33746	316%
Italy	37	97689	10779	5217	59138	64%
China	68	82122	3304	123	81397	0%
Spain	29	80110	6803	6875	28603	180%
Germany	30	62095	533	4400	24873	148%
France	31	40708	2611	2603	16214	152%
Iran	35	38309	2640	2901	21638	76%
United Kingdom	19	19780	1231	2468	5741	244%
Switzerland	27	14829	300	753	7474	100%
Netherlands	25	10930	772	1111	4217	160%
Belgium	25	10836	431	1702	3401	220%
Korea, South	39	9583	152	105	8897	8%
Turkey	12	9217	131	1815	1236	644%
Austria	24	8788	86	517	3580	144%
Canada	23	6280	64	704	1470	328%
Portugal	19	5962	119	792	1600	272%
Norway	26	4284	25	269	2263	88%
Brazil	18	4256	136	352	1546	176%
Israel	20	4247	15	628	1071	296%
Australia	26	3984	16	344	1490	168%
Sweden	25	3700	110	253	1931	92%
Czechia	19	2817	16	186	1120	152%
Ireland	17	2615	46	200	906	188%
Denmark	21	2564	72	198	1514	68%
Malaysia	26	2470	35	150	1306	88%
Chile	16	2139	7	230	632	240%
Luxembourg	16	1950	21	119	798	144%
Ecuador	13	1924	58	101	789	144%
Japan	43	1866	54	173	1086	72%

Country_Region	days_50	conf	deaths	new_conf	conf_lag7	l7_rate
Poland	17	1862	22	224	634	192%
Romania	17	1815	43	363	433	320%
Pakistan	15	1597	14	102	776	104%
Russia	16	1534	8	270	367	316%
Philippines	18	1418	71	343	380	272%
Thailand	23	1388	7	143	599	132%
Saudi Arabia	17	1299	8	96	511	156%
Indonesia	17	1285	114	130	514	152%
South Africa	15	1280	2	93	274	368%
Finland	19	1240	11	73	626	100%
Greece	22	1156	38	95	624	84%
India	20	1024	27	37	396	160%
Iceland	23	1020	2	57	568	80%
World	24	694858	33401	56723	326379	112%

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.

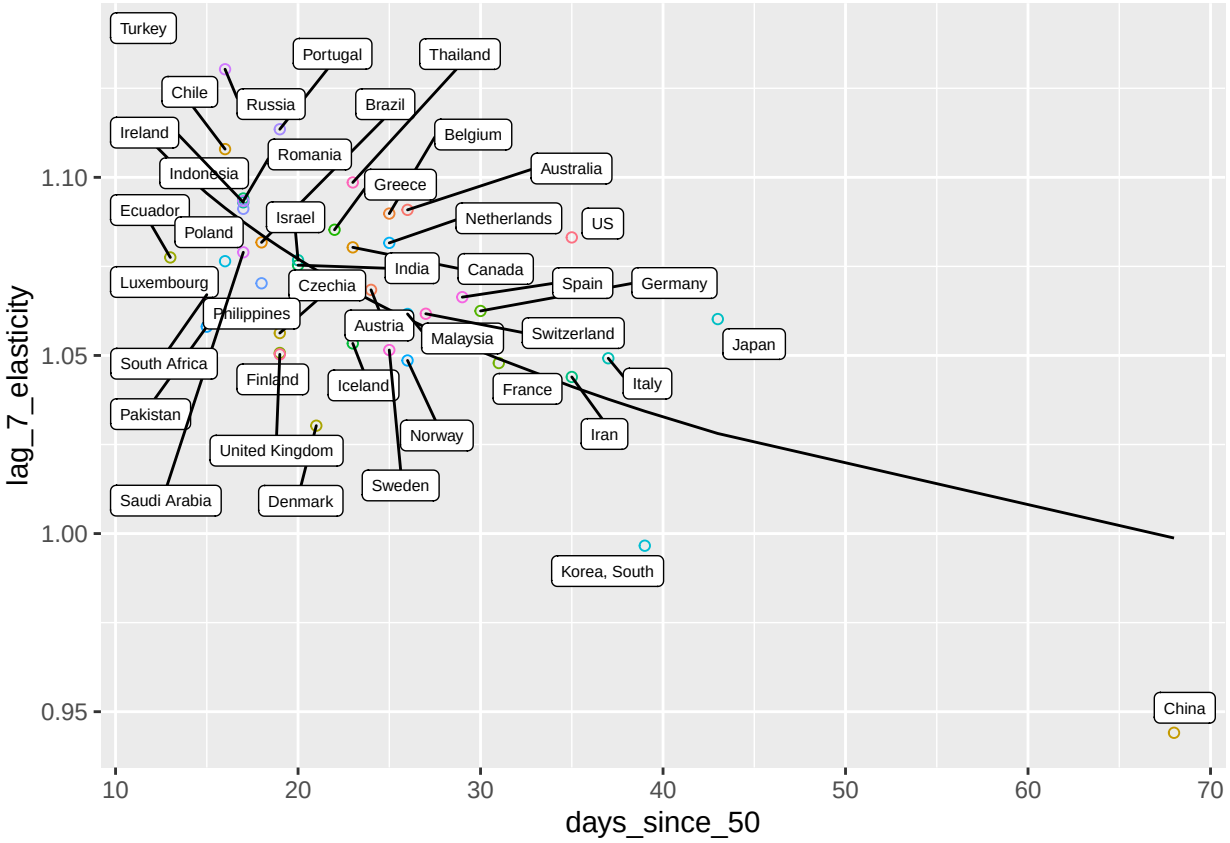
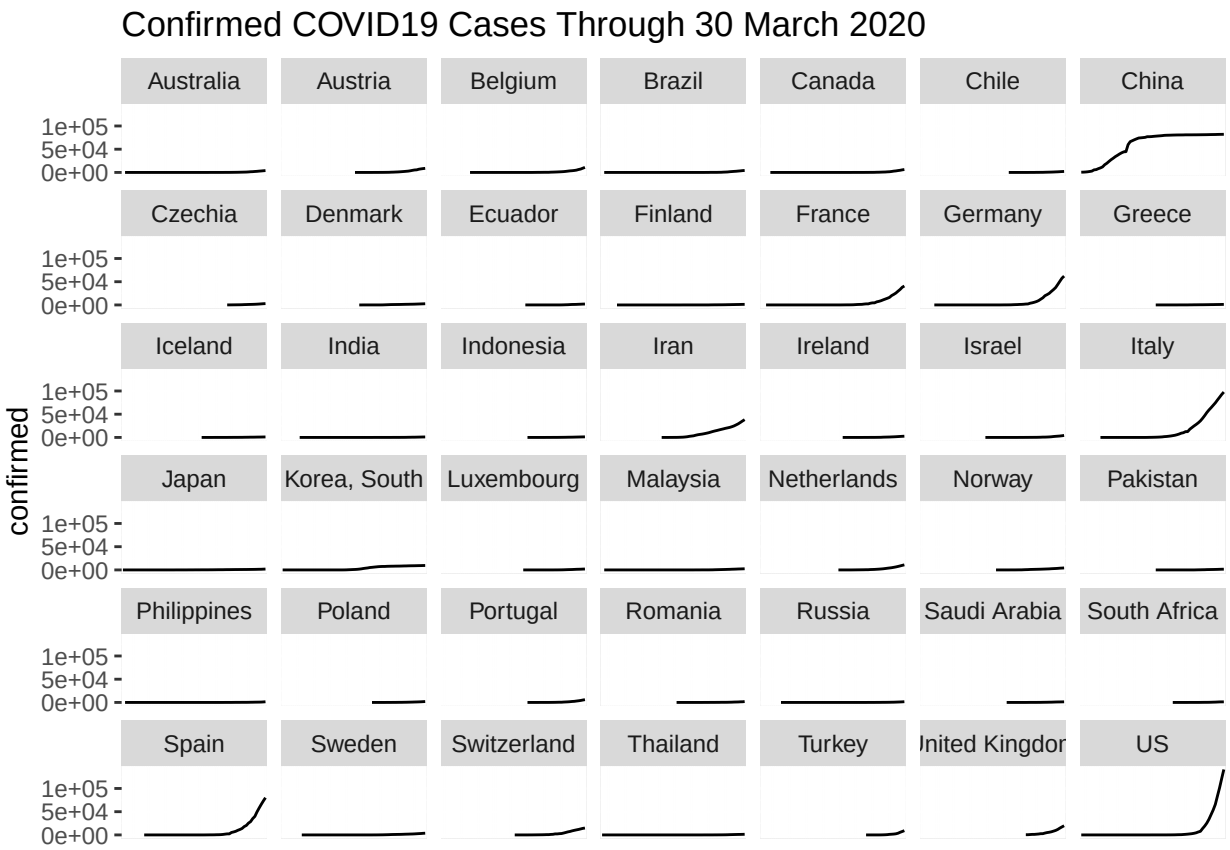


Table 2: Countries by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

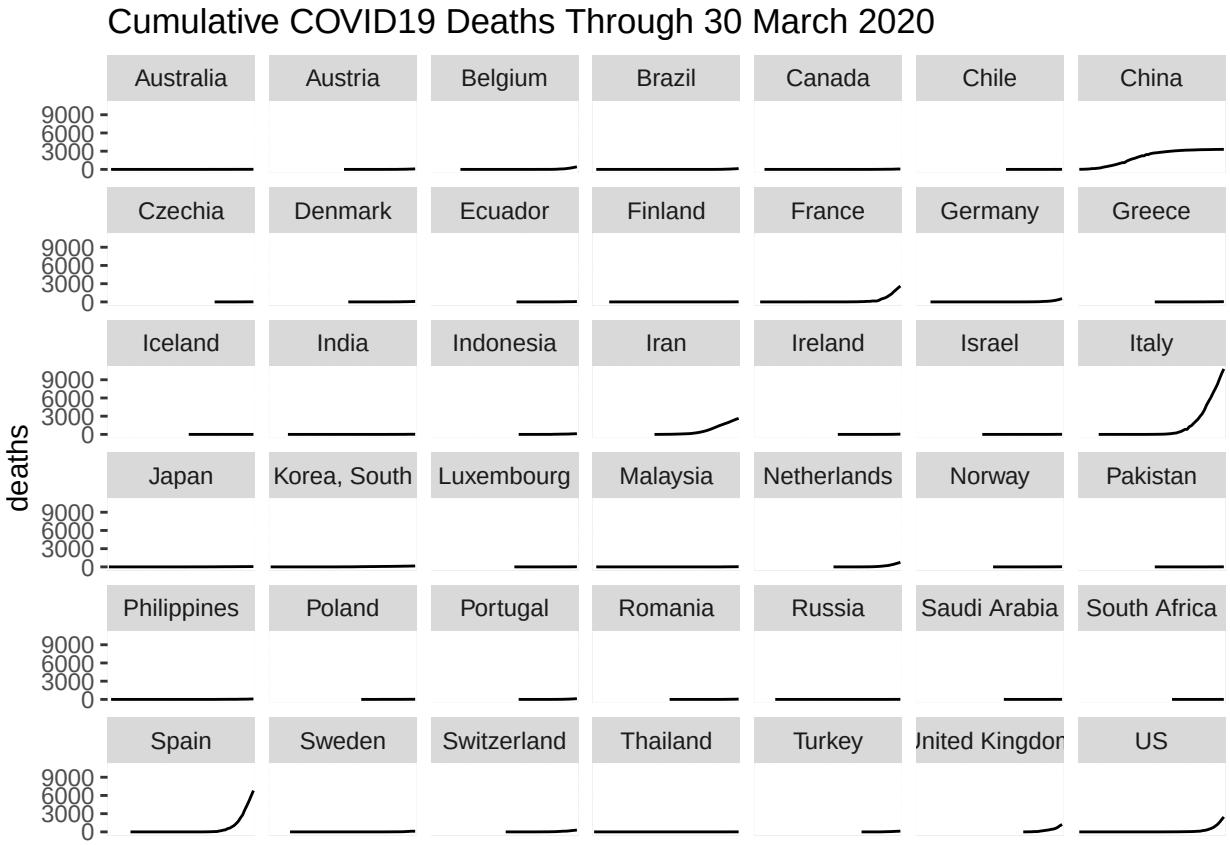
country	days_since_50	lag_7_elasticity	prediction	residual
Turkey	12	1.14	1.11	0.03
Ecuador	13	1.08	1.10	-0.03
Pakistan	15	1.06	1.10	-0.04
South Africa	15	1.07	1.10	-0.03
Luxembourg	16	1.08	1.09	-0.01
Chile	16	1.11	1.09	0.02
Russia	16	1.13	1.09	0.04
Saudi Arabia	17	1.08	1.09	-0.01
Poland	17	1.09	1.09	0.00
Ireland	17	1.09	1.09	0.01
Romania	17	1.09	1.09	0.01
Indonesia	17	1.09	1.09	0.01
Philippines	18	1.07	1.08	-0.01
Brazil	18	1.08	1.08	0.00
United Kingdom	19	1.05	1.08	-0.03
Finland	19	1.05	1.08	-0.03
Czechia	19	1.06	1.08	-0.02
Portugal	19	1.11	1.08	0.03
India	20	1.08	1.08	0.00
Israel	20	1.08	1.08	0.00
Denmark	21	1.03	1.07	-0.04
Greece	22	1.09	1.07	0.01
Iceland	23	1.05	1.07	-0.01
Canada	23	1.08	1.07	0.01
Thailand	23	1.10	1.07	0.03
Austria	24	1.07	1.07	0.00
Sweden	25	1.05	1.06	-0.01
Netherlands	25	1.08	1.06	0.02
Belgium	25	1.09	1.06	0.03
Norway	26	1.05	1.06	-0.01
Malaysia	26	1.06	1.06	0.00
Australia	26	1.09	1.06	0.03
Switzerland	27	1.06	1.06	0.00
Spain	29	1.07	1.05	0.01
Germany	30	1.06	1.05	0.01
France	31	1.05	1.05	0.00
Iran	35	1.04	1.04	0.00
US	35	1.08	1.04	0.04
Italy	37	1.05	1.04	0.01
Korea, South	39	1.00	1.03	-0.04
Japan	43	1.06	1.03	0.03
China	68	0.94	1.00	-0.05

Sparklines

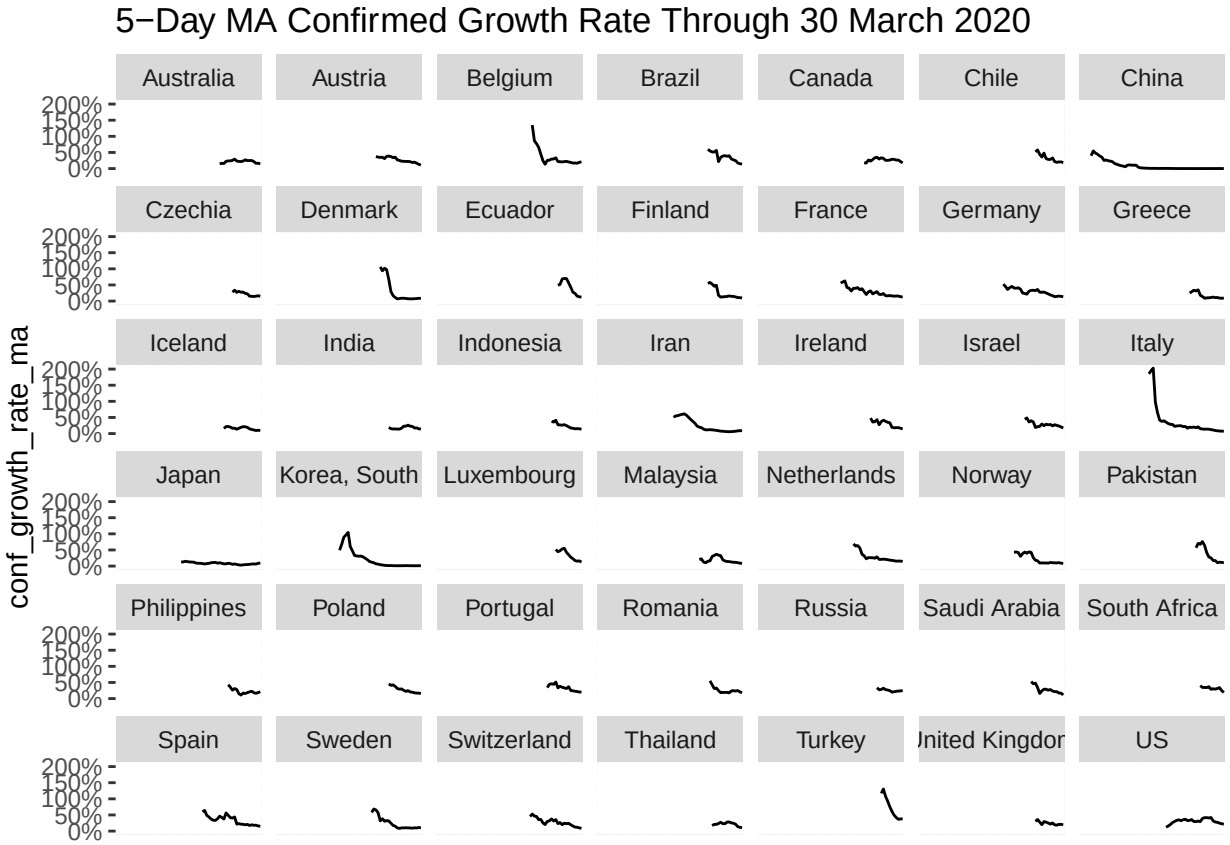
Confirmed Cases



Deaths


Cumulative COVID19 Deaths Through 30 March 2020
deaths
Australia
Austria
Belgium
Brazil
Canada
Chile
China
Czechia
Denmark
Ecuador
Finland
France
Germany
Greece
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Japan
Korea, South
Luxembourg
Malaysia
Netherlands
Norway
Pakistan
Philippines
Poland
Portugal
Romania
Russia
Saudi Arabia
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
US
9000
6000
3000
0

Confirmed Growth Rate 5-Day Moving Average



Death Rate

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	l7_rate
New York	23	59648	965	7238	15800	276%
New Jersey	16	13386	161	2262	1914	600%
California	25	5852	124	757	1646	256%
Michigan	14	5488	132	838	1035	432%
Massachusetts	20	4955	48	698	646	668%
Illinois	16	4596	66	1105	1049	340%
Washington	25	4465	198	435	1997	124%
Florida	17	4246	56	483	1004	324%
Louisiana	16	3540	151	225	837	324%
Pennsylvania	15	3432	41	587	509	576%
Texas	16	2792	37	337	643	336%
Georgia	16	2651	80	285	621	328%
Colorado	16	2307	47	567	591	292%
Connecticut	13	1993	34	469	327	508%
Tennessee	14	1720	8	209	505	240%
Ohio	14	1653	29	247	356	364%

Province_State	days_50	conf	deaths	new_conf	conf_lag7	l7_rate
Indiana	11	1513	32	280	204	640%
Maryland	13	1239	10	244	244	408%
North Carolina	13	1191	7	171	305	292%
Wisconsin	13	1164	18	109	381	204%
Nevada	13	920	15	294	190	384%
Arizona	10	919	17	146	152	504%
Missouri	10	915	13	79	87	952%
Virginia	13	890	20	150	220	304%
Alabama	11	825	10	131	157	424%
South Carolina	11	774	16	114	196	296%
Mississippi	11	759	14	96	207	268%
Utah	13	720	2	118	162	344%
Oregon	13	548	13	69	161	240%
Minnesota	14	503	9	62	167	200%
Kentucky	9	438	9	45	103	324%
Oklahoma	9	429	16	52	67	540%
Arkansas	11	426	6	17	165	160%
District of Columbia	10	342	5	38	102	236%
Iowa	9	336	4	38	90	272%
Kansas	9	330	7	64	65	408%
Rhode Island	10	294	3	55	83	256%
Idaho	7	281	5	47	42	568%
Maine	11	253	3	42	89	184%
New Mexico	8	237	2	29	57	316%
Vermont	8	235	12	24	52	352%
Delaware	8	232	6	18	56	316%
New Hampshire	9	214	2	27	74	188%
Montana	6	154	1	25	34	352%
Hawaii	8	149	0	0	53	180%
Puerto Rico	5	127	3	27	23	452%
West Virginia	4	113	0	17	16	608%
Nebraska	8	108	2	12	51	112%
Alaska	4	102	2	17	20	408%
US	12	140404	2461	19399	33555	320%

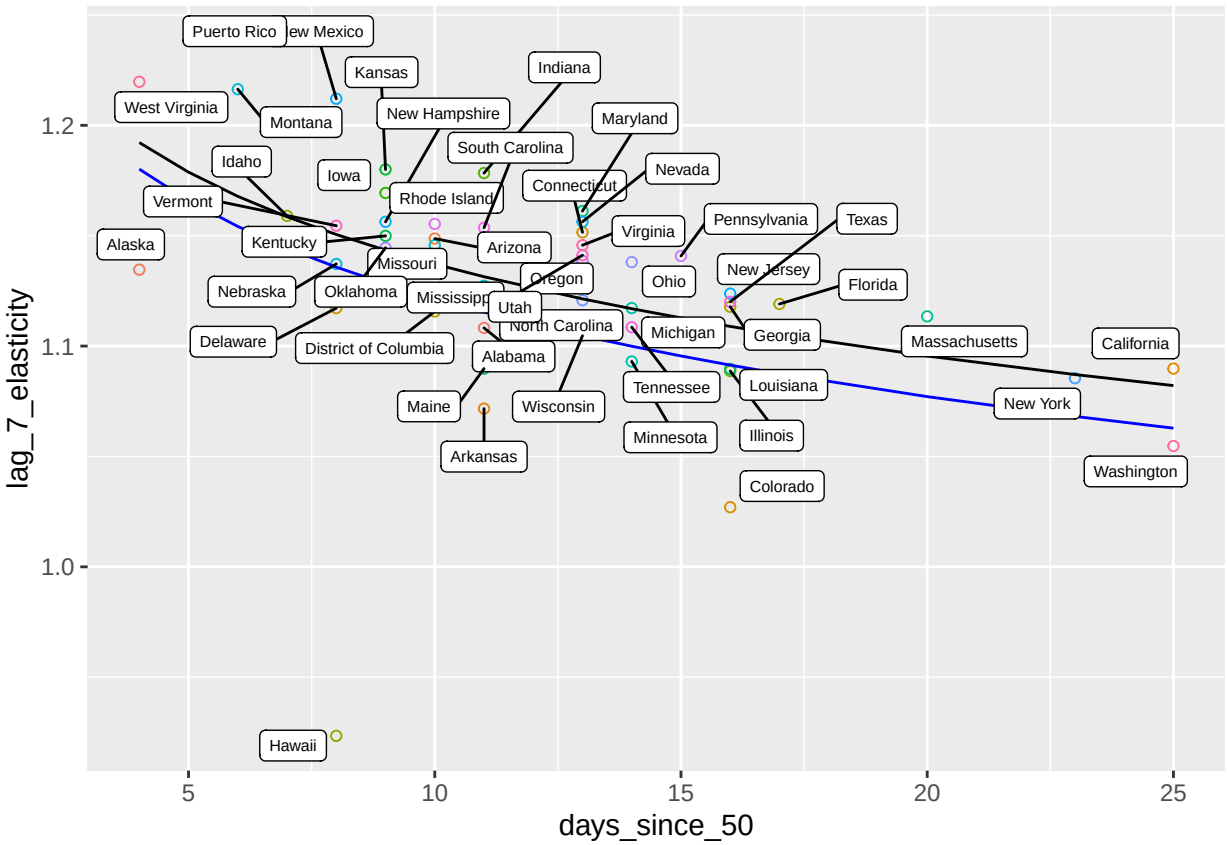
Ln (Seven-Day-Moving-Average New Cases) Impact on Ln (New Cases)

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
Alaska	4	1.13	1.19	1.18	-0.06	-0.05
West Virginia	4	1.22	1.19	1.18	0.03	0.04
Puerto Rico	5	1.24	1.18	1.17	0.06	0.07
Montana	6	1.22	1.17	1.15	0.05	0.06
Idaho	7	1.16	1.16	1.14	0.00	0.01
Hawaii	8	0.92	1.15	1.14	-0.23	-0.21
Delaware	8	1.12	1.15	1.14	-0.03	-0.02
Nebraska	8	1.14	1.15	1.14	-0.01	0.00
Vermont	8	1.15	1.15	1.14	0.00	0.02
New Mexico	8	1.21	1.15	1.14	0.06	0.08
Oklahoma	9	1.14	1.14	1.13	0.00	0.02
Kentucky	9	1.15	1.14	1.13	0.01	0.02
New Hampshire	9	1.16	1.14	1.13	0.01	0.03
Iowa	9	1.17	1.14	1.13	0.03	0.04
Kansas	9	1.18	1.14	1.13	0.04	0.05
District of Columbia	10	1.12	1.14	1.12	-0.02	-0.01
Missouri	10	1.15	1.14	1.12	0.01	0.02
Arizona	10	1.15	1.14	1.12	0.01	0.03

state	days_since_50	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
Rhode Island	10	1.16	1.14	1.12	0.02	0.03
Arkansas	11	1.07	1.13	1.12	-0.06	-0.04
Maine	11	1.09	1.13	1.12	-0.04	-0.03
Alabama	11	1.11	1.13	1.12	-0.02	-0.01
Mississippi	11	1.13	1.13	1.12	0.00	0.01
South Carolina	11	1.15	1.13	1.12	0.02	0.04
Indiana	11	1.18	1.13	1.12	0.05	0.06
Wisconsin	13	1.10	1.12	1.10	-0.02	0.00
North Carolina	13	1.12	1.12	1.10	0.00	0.02
Oregon	13	1.14	1.12	1.10	0.02	0.03
Utah	13	1.14	1.12	1.10	0.02	0.04
Virginia	13	1.15	1.12	1.10	0.02	0.04
Connecticut	13	1.15	1.12	1.10	0.03	0.05
Nevada	13	1.16	1.12	1.10	0.03	0.05
Maryland	13	1.16	1.12	1.10	0.04	0.06
Minnesota	14	1.09	1.12	1.10	-0.02	-0.01
Tennessee	14	1.11	1.12	1.10	-0.01	0.01
Michigan	14	1.12	1.12	1.10	0.00	0.02
Ohio	14	1.14	1.12	1.10	0.02	0.04
Pennsylvania	15	1.14	1.11	1.10	0.03	0.05
Colorado	16	1.03	1.11	1.09	-0.08	-0.06
Illinois	16	1.09	1.11	1.09	-0.02	0.00
Louisiana	16	1.09	1.11	1.09	-0.02	0.00
Georgia	16	1.12	1.11	1.09	0.01	0.03
Texas	16	1.12	1.11	1.09	0.01	0.03
New Jersey	16	1.12	1.11	1.09	0.01	0.03
Florida	17	1.12	1.11	1.09	0.01	0.03
Massachusetts	20	1.11	1.10	1.08	0.02	0.04
New York	23	1.09	1.09	1.07	0.00	0.02
Washington	25	1.05	1.08	1.06	-0.03	-0.01
California	25	1.09	1.08	1.06	0.01	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
Colorado	13,481	567	2020-03-29	5,268,367	0.3%
New Jersey	1,189,293	66,363	2020-04-15	8,899,339	13.4%
New York	1,712,915	72,133	2020-04-16	19,651,127	8.7%
Arkansas	4,617	72	2020-04-19	2,959,373	0.2%
Indiana	1,234,700	90,785	2020-04-19	6,570,902	18.8%
Connecticut	555,220	31,625	2020-04-21	3,596,080	15.4%
Massachusetts	762,457	34,745	2020-04-22	6,692,824	11.4%
Pennsylvania	1,787,617	103,776	2020-04-22	12,773,801	14.0%
Maryland	960,292	59,159	2020-04-24	5,928,814	16.2%
Michigan	917,534	38,386	2020-04-24	9,895,622	9.3%
Nevada	426,671	23,042	2020-04-25	2,790,136	15.3%
Washington	78,439	1,406	2020-04-27	6,971,406	1.1%

state	total_cases	peak_new_cases	date	population	perc_pop_infected
Florida	1,928,855	85,385	2020-04-29	19,552,860	9.9%
Louisiana	197,339	5,014	2020-04-29	4,625,470	4.3%
Maine	6,221	89	2020-04-29	1,328,302	0.5%
Ohio	1,324,862	63,074	2020-04-30	11,570,808	11.5%
Georgia	876,507	33,550	2020-05-01	9,992,167	8.8%
Illinois	430,595	10,702	2020-05-02	12,882,135	3.3%
South Carolina	567,378	25,609	2020-05-02	4,774,839	11.9%
Arizona	668,926	27,711	2020-05-03	6,626,624	10.1%
Missouri	580,193	23,035	2020-05-03	6,044,171	9.6%
Utah	319,091	12,771	2020-05-03	2,900,872	11.0%
Virginia	957,907	44,211	2020-05-03	8,260,405	11.6%
Texas	2,233,533	88,980	2020-05-05	26,448,193	8.4%
Rhode Island	111,306	3,834	2020-05-07	1,051,511	10.6%
District of Columbia	20,680	376	2020-05-08	646,449	3.2%
Tennessee	309,013	7,989	2020-05-08	6,495,978	4.8%
Mississippi	178,931	4,839	2020-05-09	2,991,207	6.0%
California	2,066,579	60,925	2020-05-10	38,332,521	5.4%
Oregon	362,602	12,777	2020-05-10	3,930,065	9.2%
Alabama	100,953	1,977	2020-05-11	4,833,722	2.1%
North Carolina	553,569	15,731	2020-05-12	9,848,060	5.6%
Wisconsin	151,859	3,111	2020-05-12	5,742,713	2.6%
Minnesota	28,352	416	2020-05-14	5,420,380	0.5%

Forecast New Cases U.S. Total

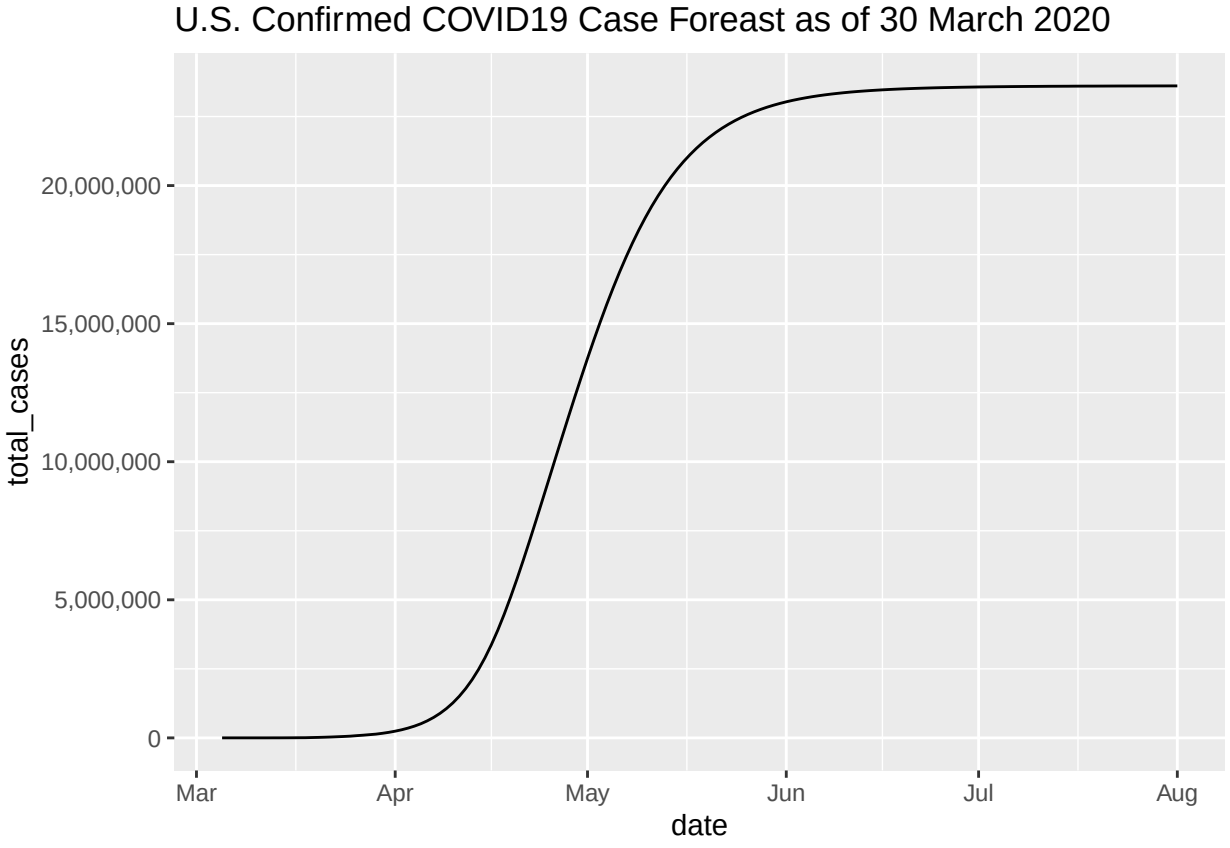
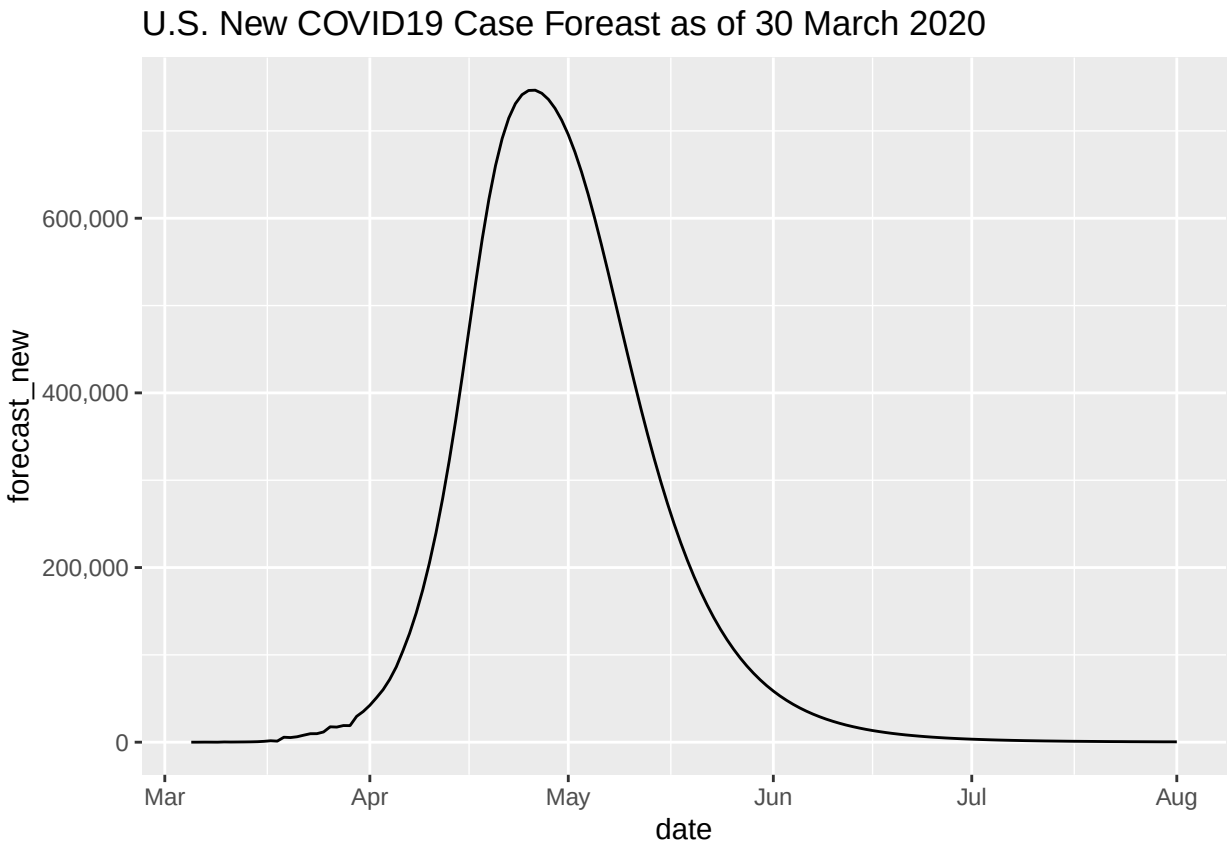


Table 6: Peak Daily New Cases in U.S. and Total on That Day

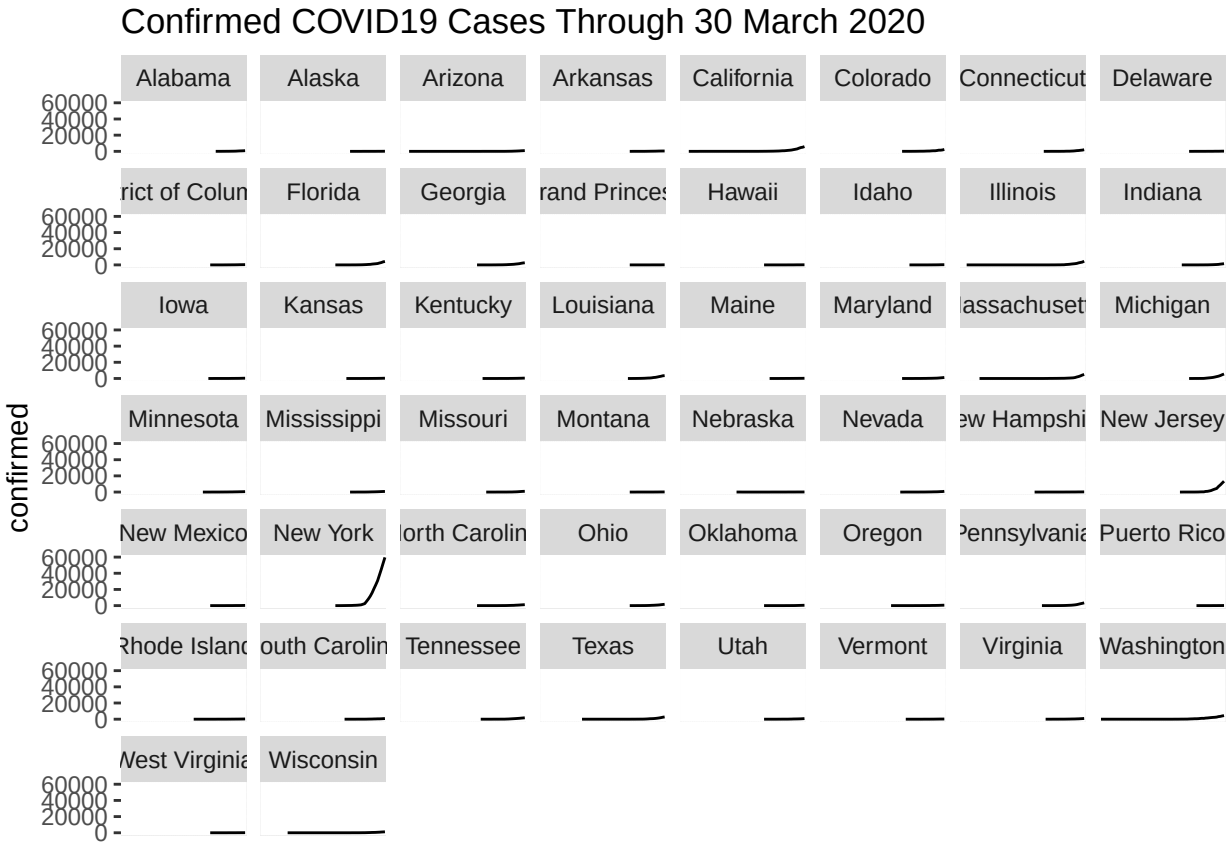
date	forecast_new	total_cases
2020-04-26	746,616	10,129,160



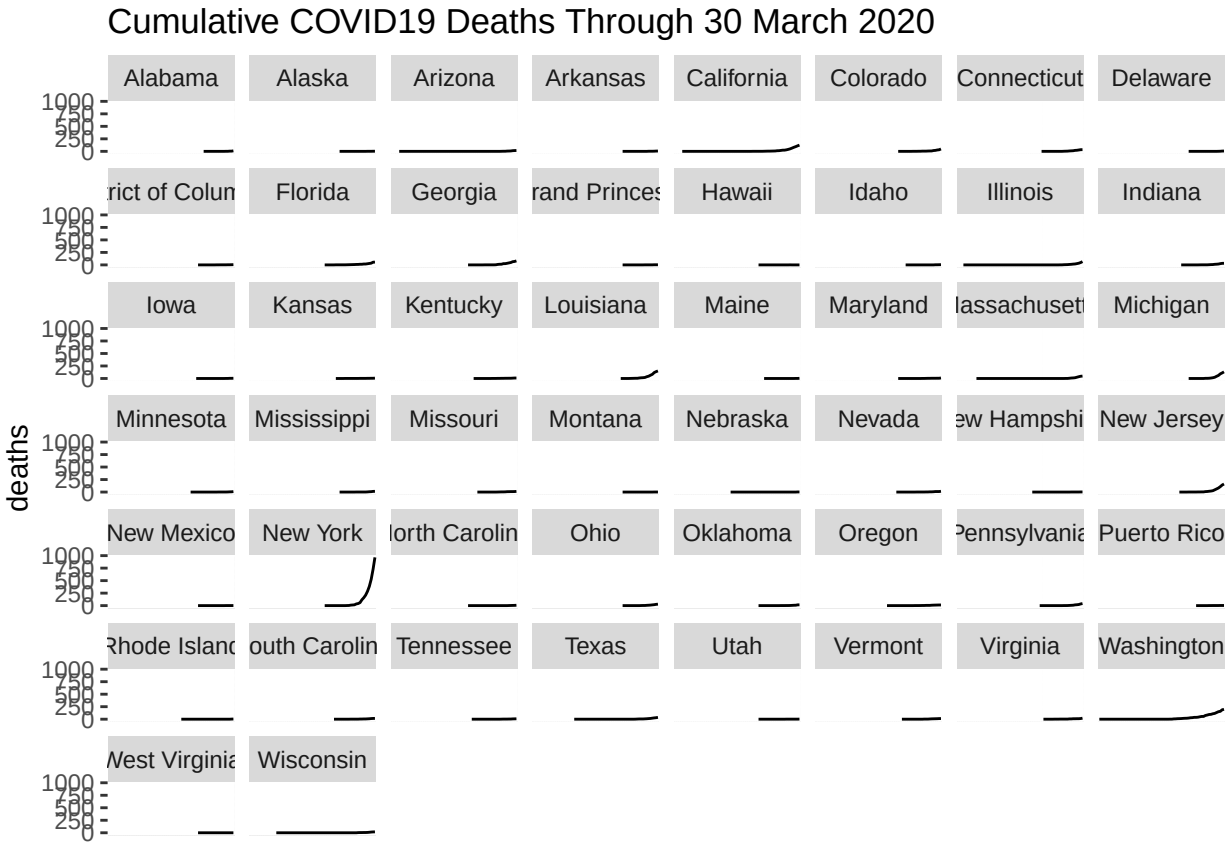
Sparklines

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



Deaths


Cumulative COVID19 Deaths Through 30 March 2020
deaths
Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
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rict of Colun
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rand Princes
Hawaii
Idaho
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Indiana
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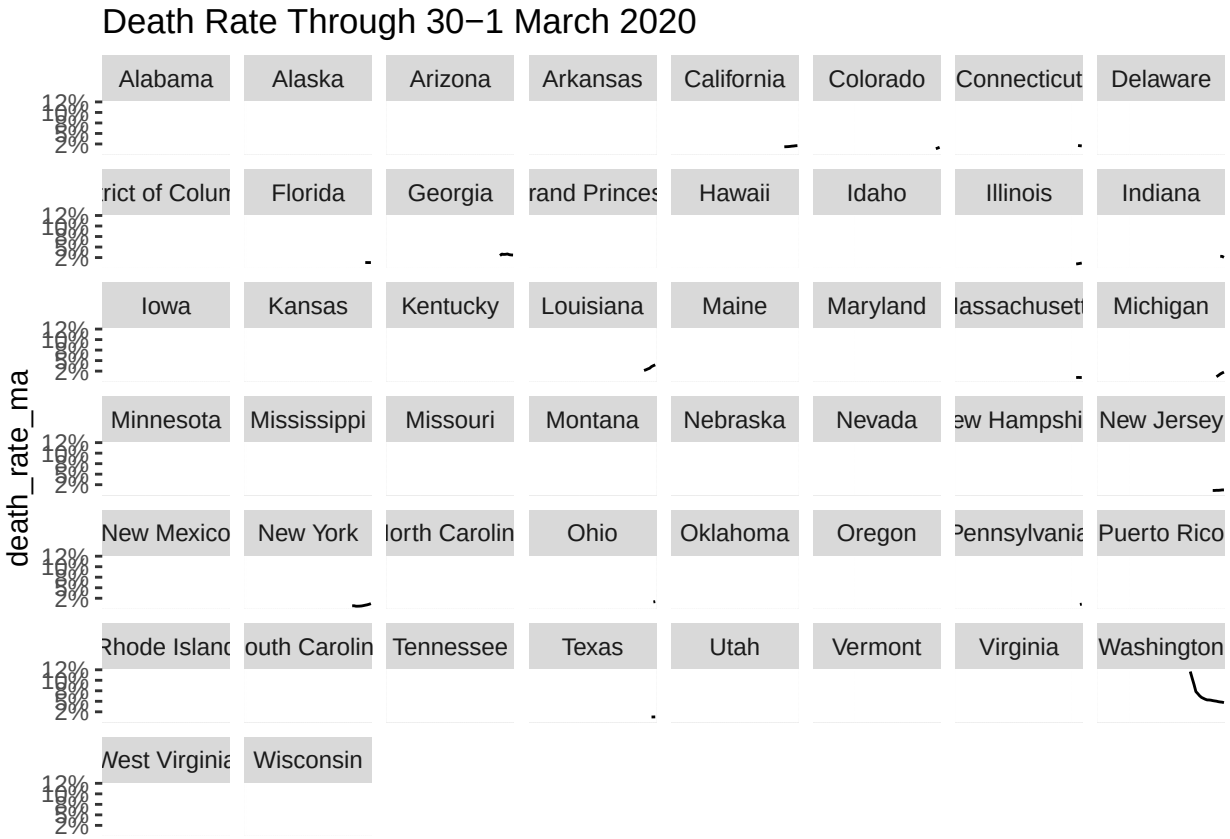
West Virginia
Wisconsin
1000
750
500
250
0

Confirmed Growth Rate 5-Day Moving Average

Death Rate 5-Day Moving Average

Only states with >25 deaths are shown


Death Rate Through 30−1 March 2020
death_rate_ma
Alabama
Alaska
Arizona
Arkansas
California
Colorado
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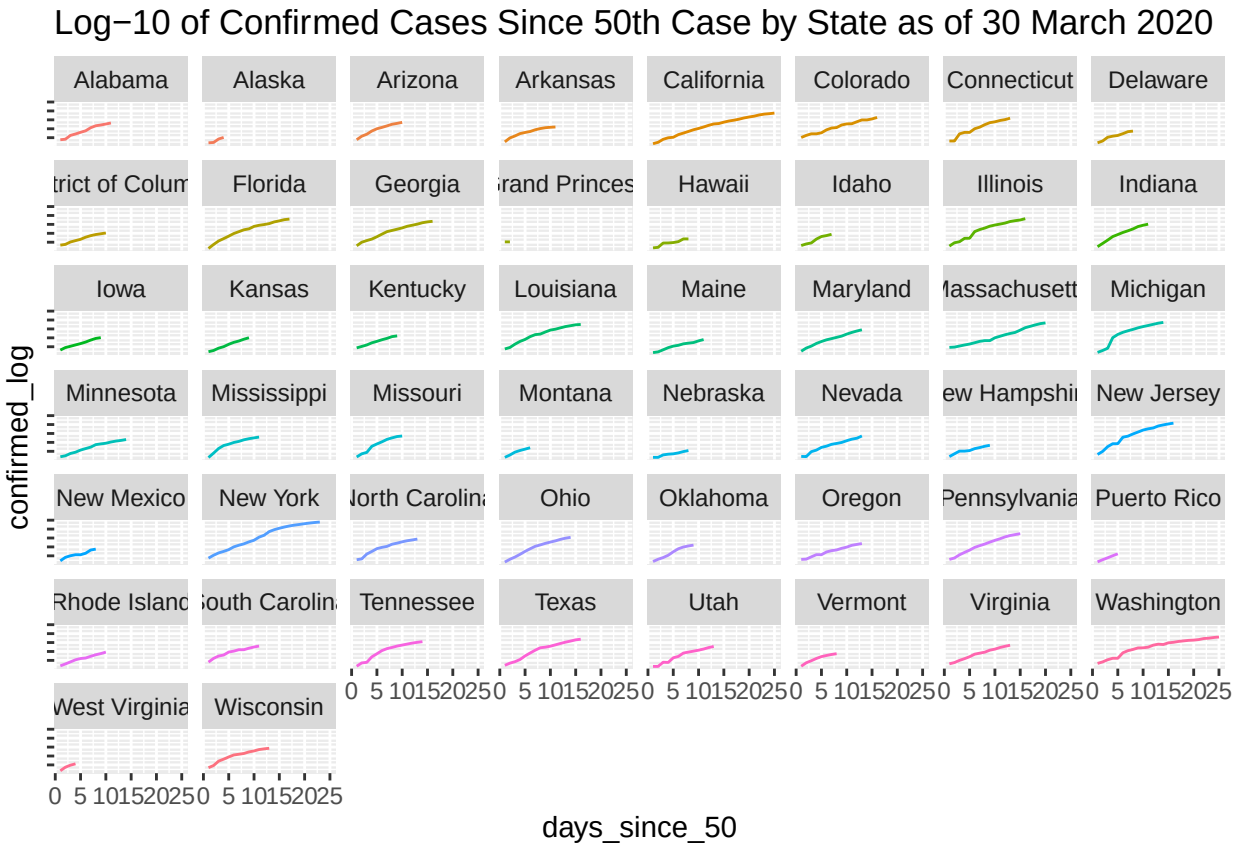
Oregon
Pennsylvania
Puerto Rico
Rhode Island
outh Carolin
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
12%
10%
8%
6%
4%
2%

Log / Time for States After 50th Case

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



Zero at Fifty Cases

Confirmed Cases