COVID19 Time Series Analysis, Worldwide and U.S.

Andy Hasselwander

27 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	32	83836	1209	18058	13680	512%
China	65	81782	3291	121	81156	0%
Italy	34	80589	8215	6203	41035	96%
Spain	26	57786	4365	8271	17963	220%
Germany	27	43938	267	6615	15320	188%
France	28	29551	1698	3951	10886	172%
Iran	32	29406	2234	2389	18407	60%
United Kingdom	16	11812	580	2172	2716	336%
Switzerland	24	11811	191	914	4075	188%
Korea, South	36	9241	131	104	8565	8%
Netherlands	22	7468	435	1030	2465	204%
Austria	21	6909	49	1321	2013	244%
Belgium	22	6235	220	1298	1795	248%
Canada	20	4042	38	791	800	404%
Turkey	9	3629	75	1196	192	1,792%
Portugal	16	3544	60	549	785	352%
Norway	23	3369	14	285	1746	92%
Brazil	15	2985	77	431	621	380%
Sweden	22	2840	77	314	1439	96%
Australia	23	2810	13	446	681	312%
Israel	17	2693	8	324	677	296%
Malaysia	23	2031	23	235	900	124%
Denmark	18	2023	41	161	1225	64%
Czechia	16	1925	9	271	694	176%
Ireland	14	1819	19	255	557	228%
Luxembourg	13	1453	9	120	335	332%
Ecuador	10	1403	34	230	199	604%
Japan	40	1387	47	80	924	52%
Chile	13	1306	4	164	238	448%

Country_Region	days_50	conf	deaths	new_conf	conf_lag7	l7_rate
Poland	14	1221	16	170	355	244%
Pakistan	12	1201	9	138	454	164%
Thailand	20	1045	4	111	272	284%
Romania	14	1029	23	123	277	272%
Saudi Arabia	14	1012	3	112	274	268%
World	22	505131	23488	58953	233721	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.

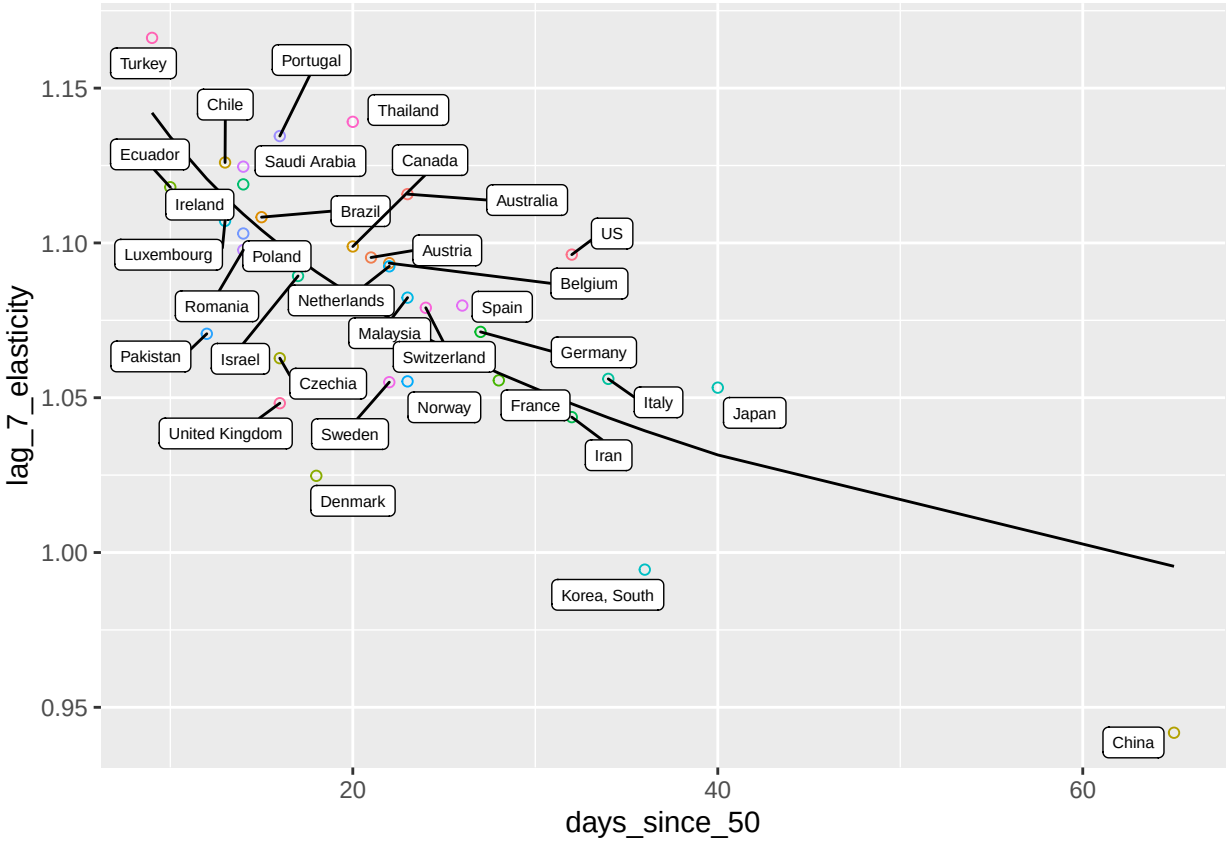


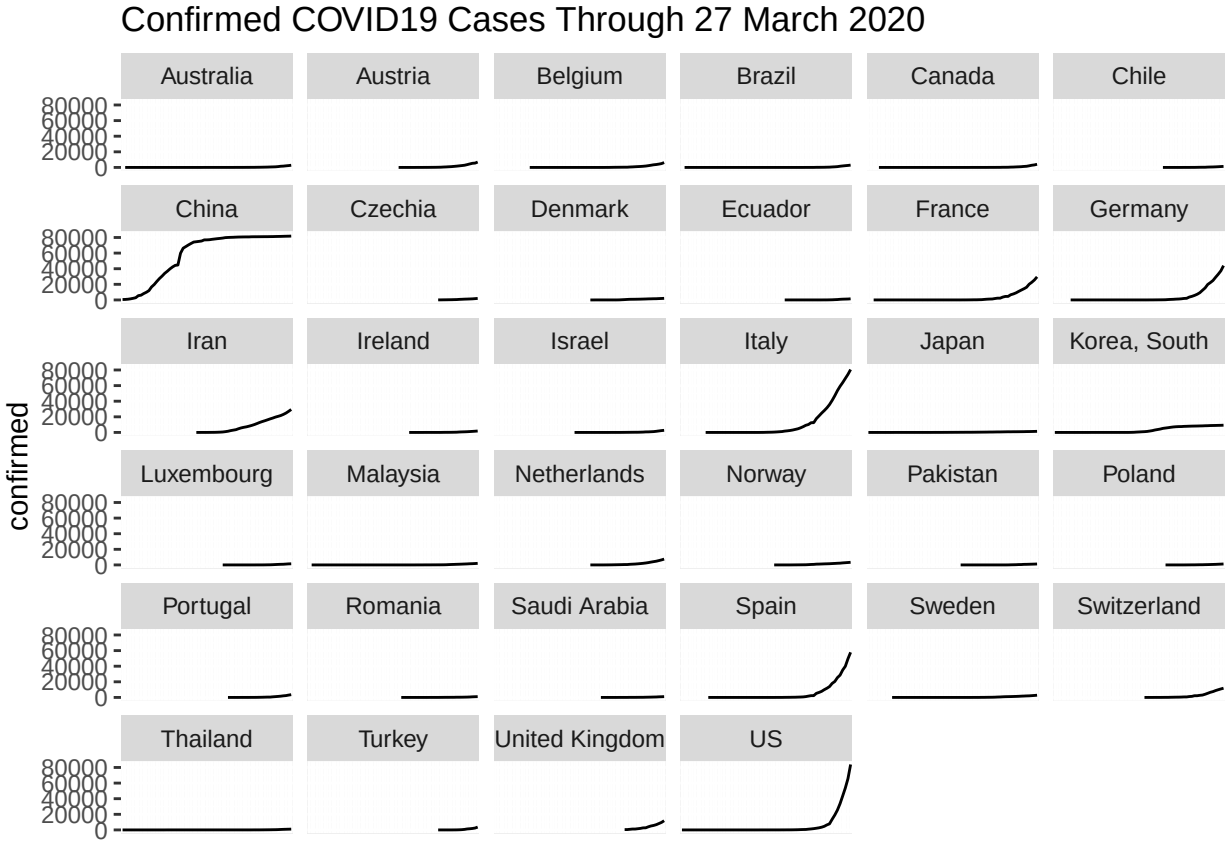
Table 2: Countries by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

country	days_since_50	lag_7_elasticity	prediction	residual
Turkey	9	1.17	1.14	0.02
Ecuador	10	1.12	1.13	-0.02
Pakistan	12	1.07	1.12	-0.05
Luxembourg	13	1.11	1.11	-0.01

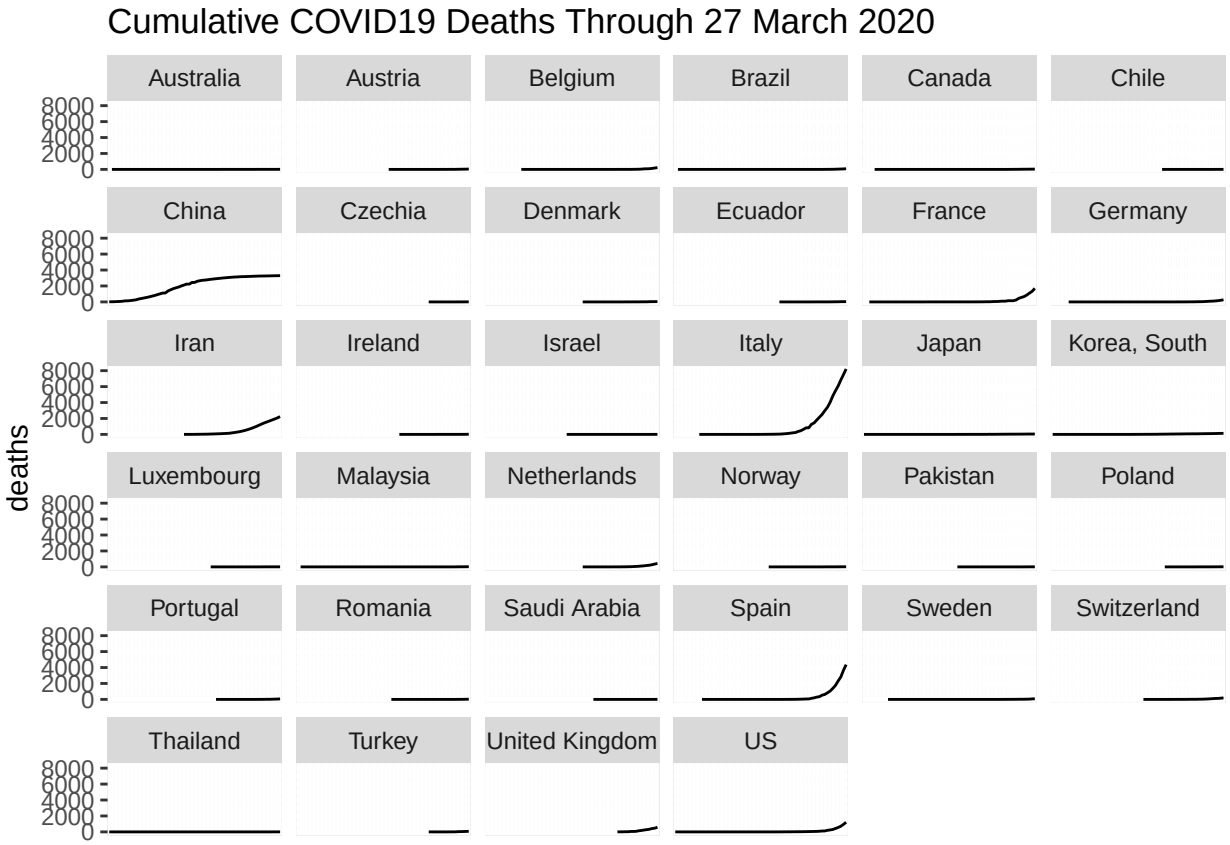
country	days_since_50	lag_7_elasticity	prediction	residual
Chile	13	1.13	1.11	0.01
Romania	14	1.10	1.11	-0.01
Poland	14	1.10	1.11	-0.01
Ireland	14	1.12	1.11	0.01
Saudi Arabia	14	1.12	1.11	0.02
Brazil	15	1.11	1.10	0.00
United Kingdom	16	1.05	1.10	-0.05
Czechia	16	1.06	1.10	-0.04
Portugal	16	1.13	1.10	0.04
Israel	17	1.09	1.09	-0.01
Denmark	18	1.02	1.09	-0.07
Canada	20	1.10	1.08	0.02
Thailand	20	1.14	1.08	0.06
Austria	21	1.10	1.08	0.02
Sweden	22	1.06	1.08	-0.02
Netherlands	22	1.09	1.08	0.02
Belgium	22	1.09	1.08	0.02
Norway	23	1.06	1.07	-0.02
Malaysia	23	1.08	1.07	0.01
Australia	23	1.12	1.07	0.04
Switzerland	24	1.08	1.07	0.01
Spain	26	1.08	1.06	0.02
Germany	27	1.07	1.06	0.01
France	28	1.06	1.06	0.00
Iran	32	1.04	1.05	0.00
US	32	1.10	1.05	0.05
Italy	34	1.06	1.04	0.01
Korea, South	36	0.99	1.04	-0.04
Japan	40	1.05	1.03	0.02
China	65	0.94	1.00	-0.05

Sparklines

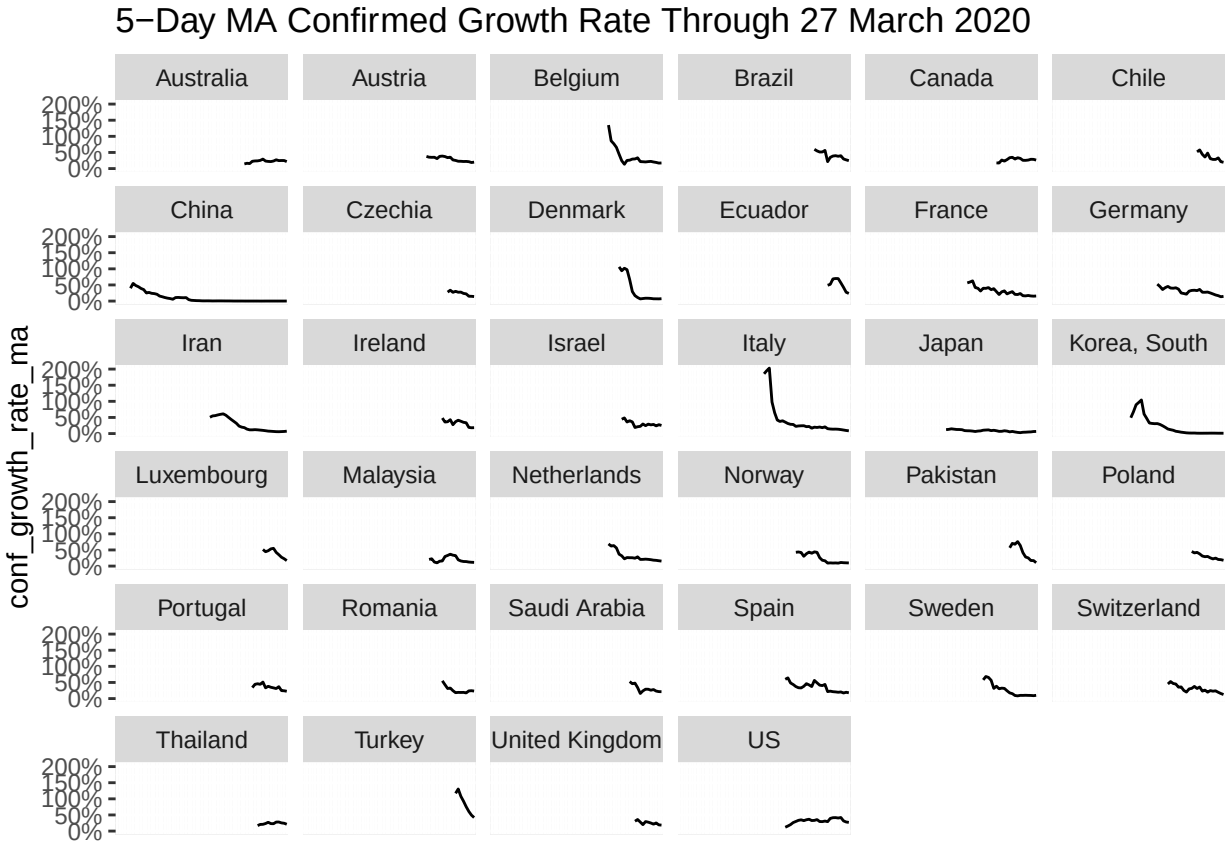
Confirmed Cases



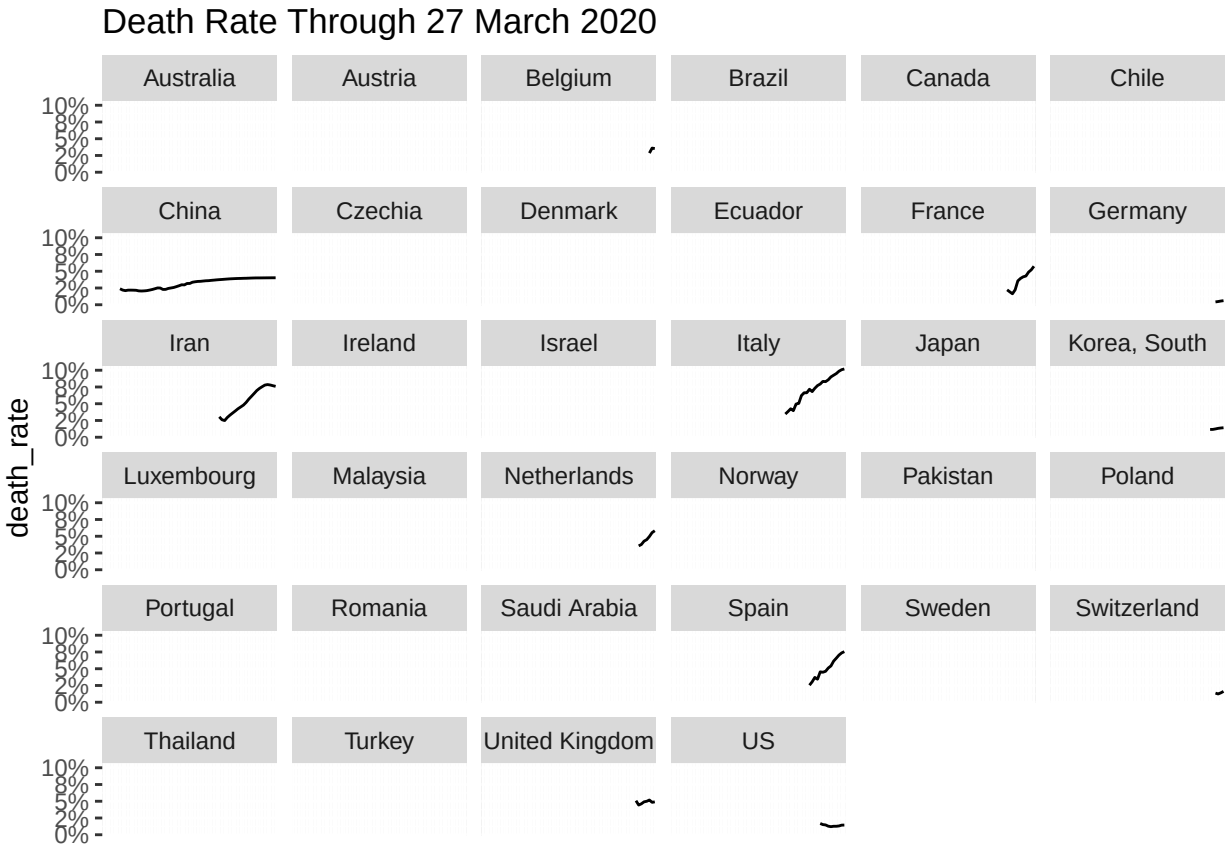
Deaths


Cumulative COVID19 Deaths Through 27 March 2020
deaths
Australia
Austria
Belgium
Brazil
Canada
Chile
China
Czechia
Denmark
Ecuador
France
Germany
Iran
Ireland
Israel
Italy
Japan
Korea, South
Luxembourg
Malaysia
Netherlands
Norway
Pakistan
Poland
Portugal
Romania
Saudi Arabia
Spain
Sweden
Switzerland
Thailand
Turkey
United Kingdom
US
0
2000
4000
6000
8000

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	20	37877	385	7036	5365	608%
New Jersey	13	6876	81	2474	742	828%
California	22	3899	81	901	952	308%
Washington	22	3207	150	616	1376	132%
Michigan	11	2845	61	549	334	752%
Illinois	13	2538	26	673	422	500%
Massachusetts	17	2417	25	579	328	636%
Florida	14	2357	29	675	417	464%
Louisiana	13	2304	83	509	392	488%
Pennsylvania	12	1795	18	535	206	772%
Texas	13	1563	21	334	260	500%
Georgia	13	1525	48	278	287	432%
Colorado	13	1430	19	409	277	416%
Tennessee	11	1097	3	181	154	612%
Connecticut	10	1012	21	137	159	536%

Province_State	days_50	conf	deaths	new_conf	conf_lag7	l7_rate
Ohio	11	868	15	164	119	628%
North Carolina	10	738	3	148	123	500%
Wisconsin	10	728	10	107	159	356%
Indiana	8	645	17	168	60	976%
Maryland	10	583	4	158	107	444%
Missouri	7	520	9	166	31	1,576%
Alabama	8	517	1	136	78	564%
Arizona	7	508	8	107	45	1,028%
Mississippi	8	485	6	108	50	868%
Virginia	10	466	10	70	99	372%
South Carolina	8	424	9	0	81	424%
Nevada	10	420	10	97	95	344%
Utah	10	396	1	56	80	396%
Minnesota	11	344	2	58	89	288%
Arkansas	8	335	2	55	62	440%
Oregon	10	316	11	50	88	260%
Oklahoma	6	248	7	84	44	464%
Kentucky	6	247	5	50	37	568%
District of Columbia	7	231	3	44	40	476%
Iowa	6	179	1	33	44	308%
Kansas	6	172	3	38	34	404%
Rhode Island	7	165	0	33	44	276%
Vermont	5	158	9	33	22	620%
Maine	8	155	0	13	52	200%
Idaho	4	146	3	55	11	1,228%
New Hampshire	6	137	1	29	44	212%
Delaware	5	130	1	11	30	332%
New Mexico	5	113	1	0	35	224%
US	10	83116	1203	17957	13474	516%

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.

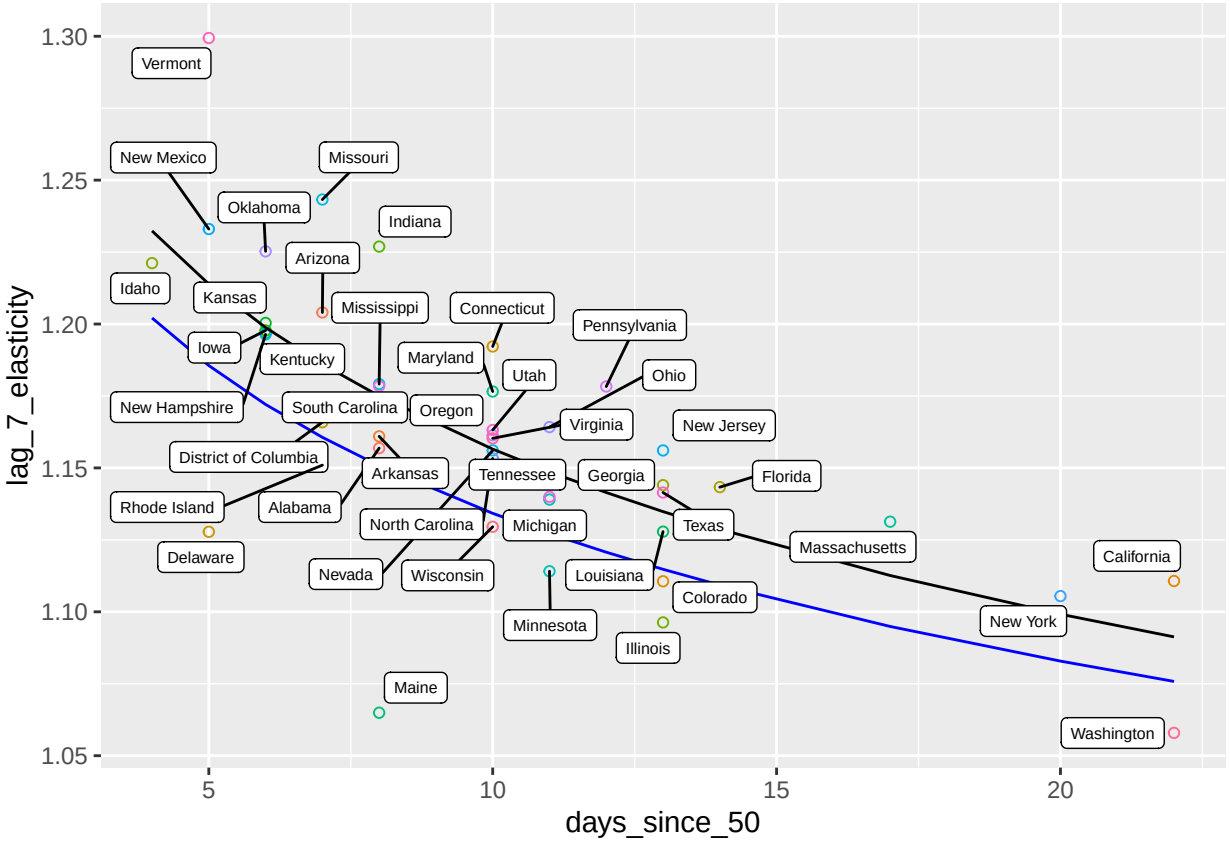


Table 4: States by Predicted vs. Actual Lag 7 New Case Elasticity on Today's Cases

state	days_since_50	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
Idaho	4	1.22	1.23	1.20	-0.01	0.02
Delaware	5	1.13	1.21	1.19	-0.09	-0.06
New Mexico	5	1.23	1.21	1.19	0.02	0.05
Vermont	5	1.30	1.21	1.19	0.09	0.11
New Hampshire	6	1.20	1.20	1.17	0.00	0.02
Kentucky	6	1.20	1.20	1.17	0.00	0.02
Iowa	6	1.20	1.20	1.17	0.00	0.03
Kansas	6	1.20	1.20	1.17	0.00	0.03
Oklahoma	6	1.23	1.20	1.17	0.03	0.05
Rhode Island	7	1.15	1.19	1.16	-0.04	-0.01
District of Columbia	7	1.17	1.19	1.16	-0.02	0.01
Arizona	7	1.20	1.19	1.16	0.02	0.04
Missouri	7	1.24	1.19	1.16	0.06	0.08
Maine	8	1.06	1.17	1.15	-0.11	-0.09
Alabama	8	1.16	1.17	1.15	-0.02	0.01
Arkansas	8	1.16	1.17	1.15	-0.01	0.01
South Carolina	8	1.18	1.17	1.15	0.00	0.03
Mississippi	8	1.18	1.17	1.15	0.00	0.03
Indiana	8	1.23	1.17	1.15	0.05	0.08
Wisconsin	10	1.13	1.16	1.13	-0.03	0.00
North Carolina	10	1.15	1.16	1.13	0.00	0.02
Nevada	10	1.16	1.16	1.13	0.00	0.02

state	days_since_50	lag_7_elasticity	prediction_us	prediction_ww	us_residual	ww_residual
Virginia	10	1.16	1.16	1.13	0.00	0.03
Oregon	10	1.16	1.16	1.13	0.00	0.03
Utah	10	1.16	1.16	1.13	0.01	0.03
Maryland	10	1.18	1.16	1.13	0.02	0.04
Connecticut	10	1.19	1.16	1.13	0.04	0.06
Minnesota	11	1.11	1.15	1.13	-0.03	-0.01
Michigan	11	1.14	1.15	1.13	-0.01	0.01
Tennessee	11	1.14	1.15	1.13	-0.01	0.01
Ohio	11	1.16	1.15	1.13	0.02	0.04
Pennsylvania	12	1.18	1.14	1.12	0.04	0.06
Illinois	13	1.10	1.13	1.11	-0.04	-0.02
Colorado	13	1.11	1.13	1.11	-0.02	0.00
Louisiana	13	1.13	1.13	1.11	-0.01	0.01
Texas	13	1.14	1.13	1.11	0.01	0.03
Georgia	13	1.14	1.13	1.11	0.01	0.03
New Jersey	13	1.16	1.13	1.11	0.02	0.04
Florida	14	1.14	1.13	1.11	0.01	0.03
Massachusetts	17	1.13	1.11	1.09	0.02	0.04
New York	20	1.11	1.10	1.08	0.01	0.02
Washington	22	1.06	1.09	1.08	-0.03	-0.02
California	22	1.11	1.09	1.08	0.02	0.03

Forecast New Cases by State

We estimate new cases by date (in development)

Table 5: Forecast Peak New Cases by State

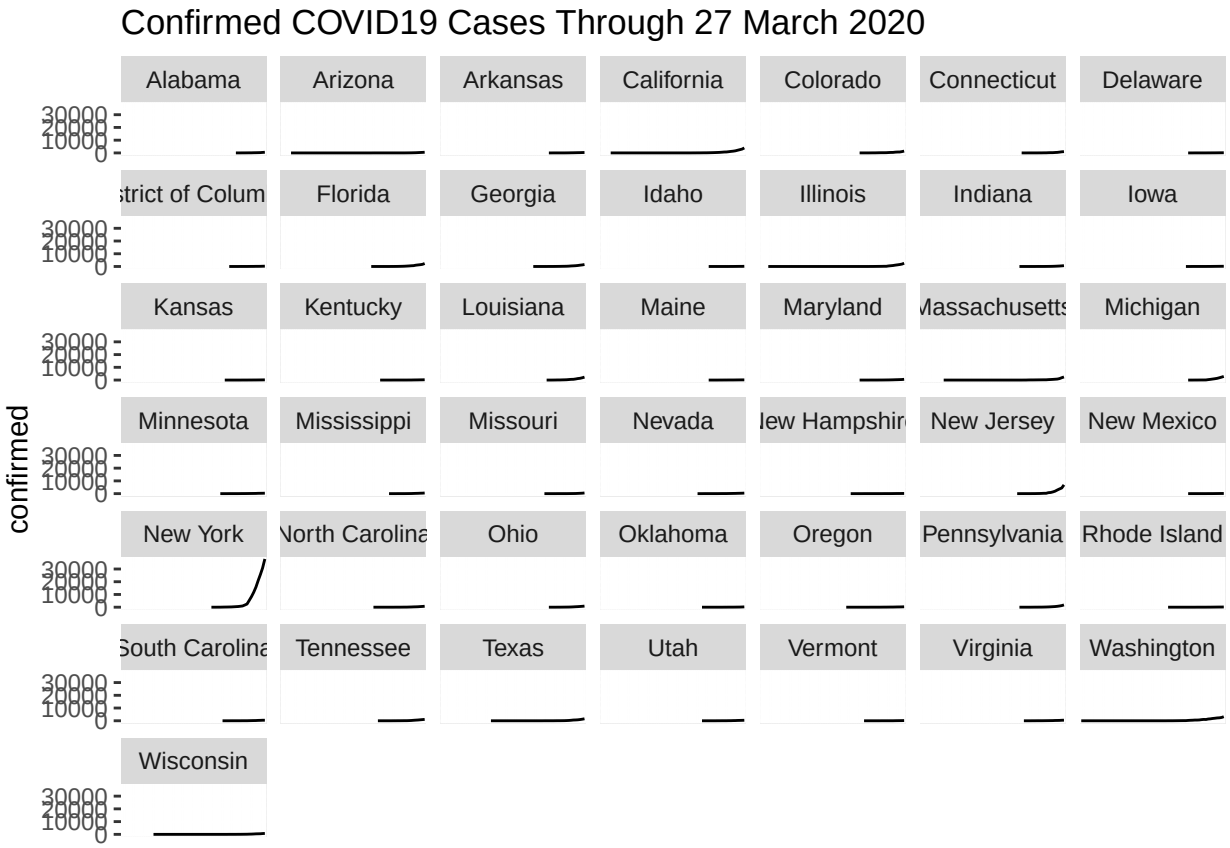
state	total_cases	peak_new_cases	date
California	564747	12499	2020-05-07
Washington	263449	5601	2020-05-07
New York	38424577	1008322	2020-05-09
Massachusetts	1281244	29428	2020-05-12
Florida	2659614	63013	2020-05-15
Colorado	1471257	33983	2020-05-16
Georgia	1502686	34738	2020-05-16
Illinois	4601528	111507	2020-05-16
Louisiana	3886337	93533	2020-05-16
New Jersey	46538683	1229476	2020-05-16
Texas	1643872	38152	2020-05-16
Pennsylvania	4292504	103731	2020-05-17
Michigan	16405830	417549	2020-05-18
Minnesota	106754	2165	2020-05-18
Ohio	1124265	25657	2020-05-18
Tennessee	1693442	39351	2020-05-18
Connecticut	2683880	63609	2020-05-19
Maryland	650424	14474	2020-05-19
Nevada	270237	5760	2020-05-19
North Carolina	1094933	24957	2020-05-19
Oregon	124414	2545	2020-05-19
Utah	246894	5238	2020-05-19
Virginia	353931	7647	2020-05-19

state	total_cases	peak_new_cases	date
Wisconsin	857367	19324	2020-05-19
Maine	34816	660	2020-05-20
Alabama	1501812	34717	2020-05-21
Arkansas	337061	7264	2020-05-21
Indiana	2746719	65161	2020-05-21
Mississippi	1109464	25302	2020-05-21
South Carolina	496695	10909	2020-05-21
Arizona	2357450	55566	2020-05-22
District of Columbia	219209	4622	2020-05-22
Missouri	3272290	78198	2020-05-22
Rhode Island	70630	1399	2020-05-22

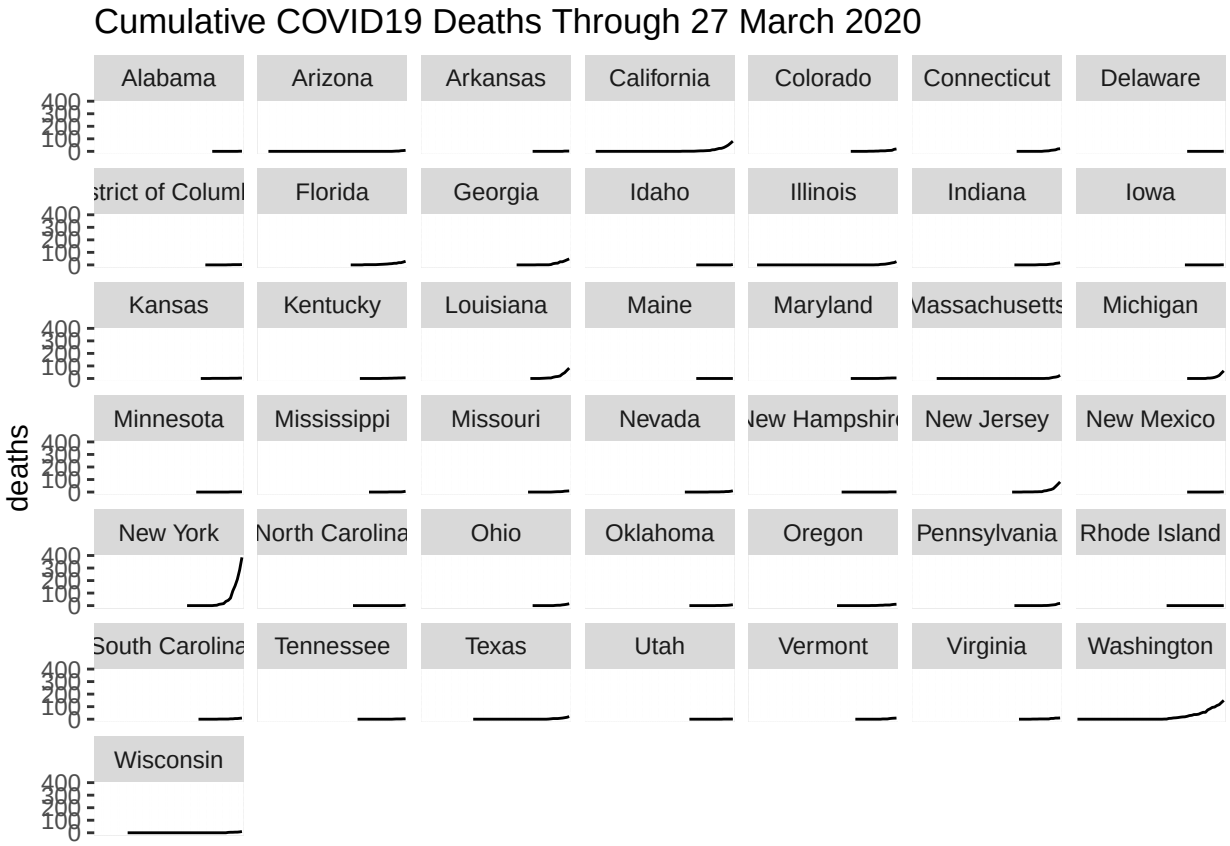
Sparklines

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.

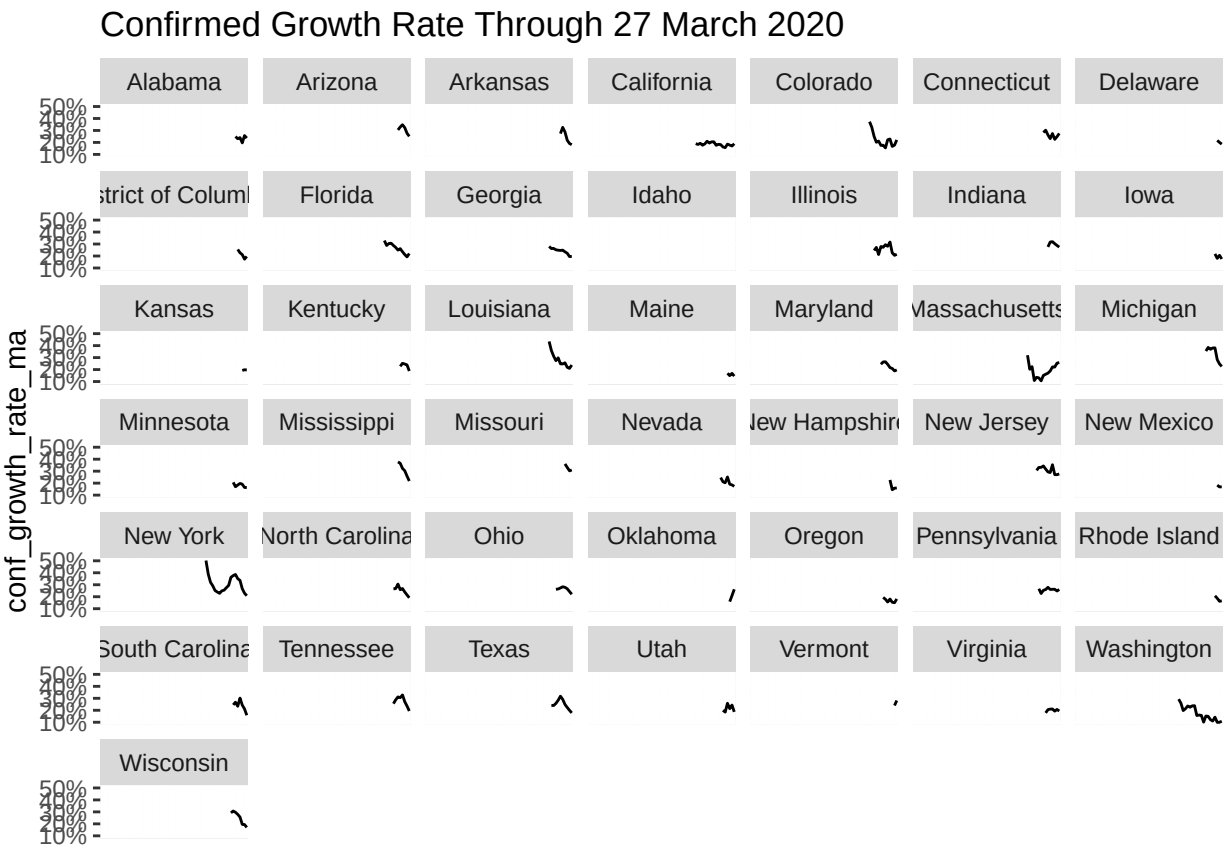
Confirmed Cases



Deaths

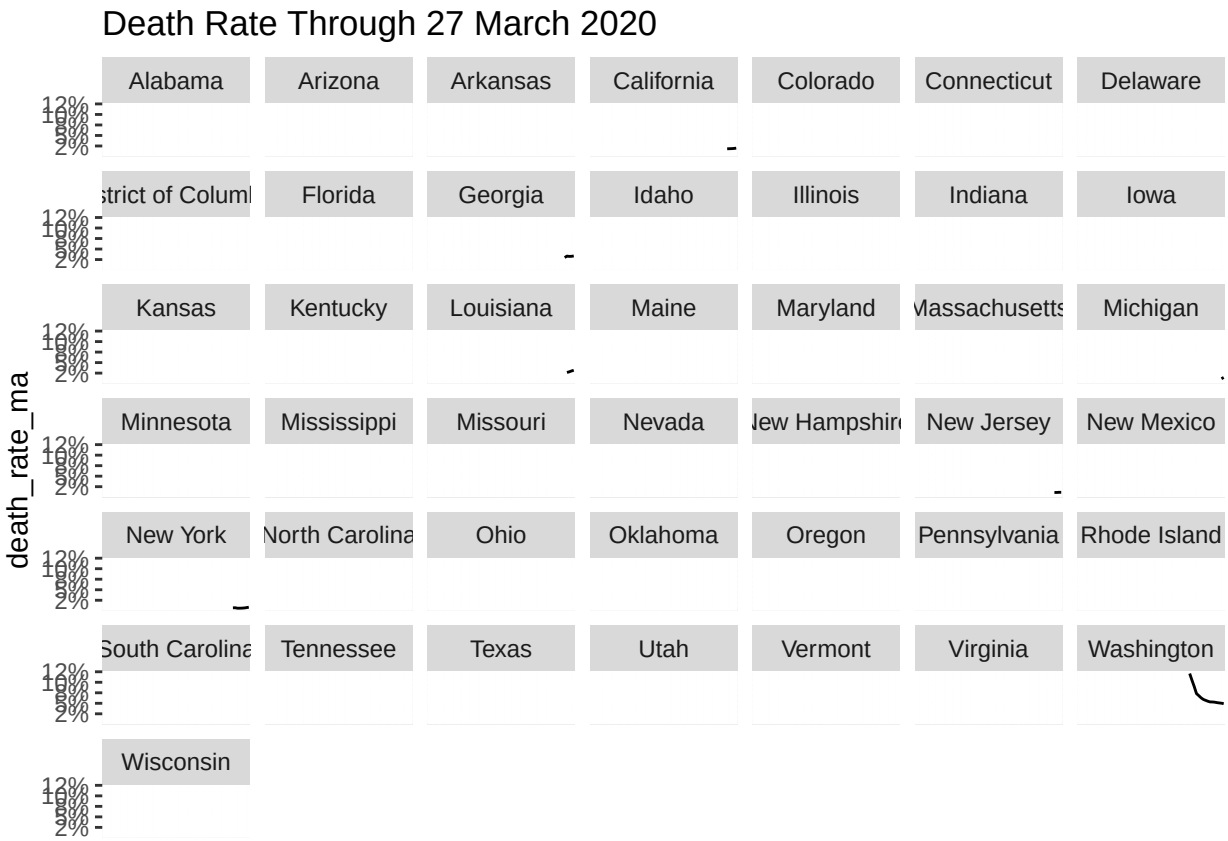

Cumulative COVID19 Deaths Through 27 March 2020
deaths
Alabama
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
Florida
Georgia
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Michigan
Minnesota
Mississippi
Missouri
Nevada
New Jersey
New Mexico
New York
North Carolina
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
Tennessee
Texas
Utah
Vermont
Virginia
Washington
Wisconsin
0
100
200
300
400

Confirmed Growth Rate 5-Day Moving Average



Death Rate 5-Day Moving Average

Only states with >25 deaths are shown


Death Rate Through 27 March 2020
death_rate_ma
Alabama
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
Florida
Georgia
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Michigan
Minnesota
Mississippi
Missouri
Nevada
New Jersey
New Mexico
New York
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
Tennessee
Texas
Utah
Vermont
Virginia
Washington
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