

Lecture 26:

6.5. The Pace and Meaning

of Economic Growth

Brad DeLong

Department of Economics & Blum Center, U.C. Berkeley; & WCEG

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for presentation: Th 2020-06-06

Original course by Melissa Dell (Harvard Econ 1342), revised by Brad DeLong

<<https://github.com;braddelong/public-files/blob/master/econ-135-lecture-26.pptx>>

Discussion

The Pace and Meaning of Economic Growth:

- What strikes you as important here?

The Pace and Meaning of Economic Growth

26. Tu May 5: 6.5. The Pace and Meaning of Economic Growth:

Readings:

- **William Nordhaus** (1996): *Do Real-Output and Real-Wage Measures Capture Reality?* <<https://www.nber.org/chapters/c6064.pdf>>
- **Edward Bellamy** (1887): *Looking Backward 2000-1887*, selections <<https://delong.typepad.com/files/bellamy-backward.pdf>>
- **John Maynard Keynes** (1931): *Economic Possibilities for Our Grandchildren* <<https://delong.typepad.com/files/keynes-persuasion.pdf>>

Materials:

- Readiness:
- Slides: <<https://github.com;braddelong/public-files/blob/master/econ-135-lecture-26.pptx>>
- Review:
- Discussion:
- Text

Background: Economic Growth

The eagle's-eye view:

- Three accelerations from agrarian-age norm: x 6.5, x 3.5, x 4.5
- I got into this business in the 1980s: Paul Romer then argued a fourth acceleration was on the way
- Did not happen (yet?)

Longest-Run Global Economic Growth (2019)

Date	ideas Level H	Total Real World Income Y (billions)	Average Real Income per Capita y (per year)	Total Human Population L (millions)	Rate of Population and Labor Force Growth n	Rate of Efficiency-of-Labor Growth g	Rate of Ideas-Stock Growth h
-1000	16.8	\$45	\$900	50	0.060%	0.000%	0.030%
1500	53.0	\$450	\$900	500	0.073%	0.000%	0.036%
1770	79.4	\$825	\$1,100	750	0.150%	0.074%	0.149%
1870	123.5	\$1,690	\$1,300	1300	0.550%	0.167%	0.442%
2020	2720.5	\$90,000	\$11,842	7600	1.177%	1.473%	2.061%

Features of Modern Economic Growth

As conventionally measured:

- Ideas growth of 2.1%/yr:
 - Doubling time of 33 years
 - More change in one year than in 50 in the agrarian age
 - Enormous growth in global inequality
- Driven by:
 - Industrial research lab: routinization & rationalization of invention & innovation
 - Modern corporation: routinization & rationalization of the deployment of ideas
 - Globalization
 - Transport
 - Communications
 - Migration
 - Demographic transition
- American ascendancy: “the furnace where the future is being forged”

Longest-Run Global Economic Growth (2019)

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-1000	16.8	\$45	\$900	50	0.060%	0.000%	0.030%
0	30.9	\$153	\$900	170	0.122%	0.000%	0.061%
800	41.1	\$270	\$900	300	0.071%	0.000%	0.035%
1500	53.0	\$450	\$900	500	0.073%	0.000%	0.036%
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Global Growth: The Advanced West (2019)

Date	ideas Level H	Total Real Income Y (billions)	Average Real Income per Capita y (per year)	Total "West" Population L (millions)	Rate of Population and Labor Force Growth n	Rate of Efficiency-of-Labor Growth g	Increasing Resources p	Rate of Ideas-Stock Growth h
-1000	15.0	\$1.80	\$900	2	0.069%	0.000%	0.000%	0.035%
0	23.7	\$4.50	\$900	5	0.092%	0.000%	0.000%	0.046%
800	30.0	\$7.20	\$900	8	0.059%	0.000%	0.000%	0.029%
1500	58.9	\$25.00	\$1,000	25	0.163%	0.015%	0.000%	0.096%
1770	101.0	\$105.00	\$1,400	75	0.407%	0.125%	0.257%	0.200%
1870	252.0	\$490.00	\$2,800	175	0.847%	0.693%	0.405%	0.914%
2020	8439.5	\$40,000.00	\$50,000	800	1.013%	1.922%	0.175%	2.341%

Are These Conventional Measures at All Accurate?

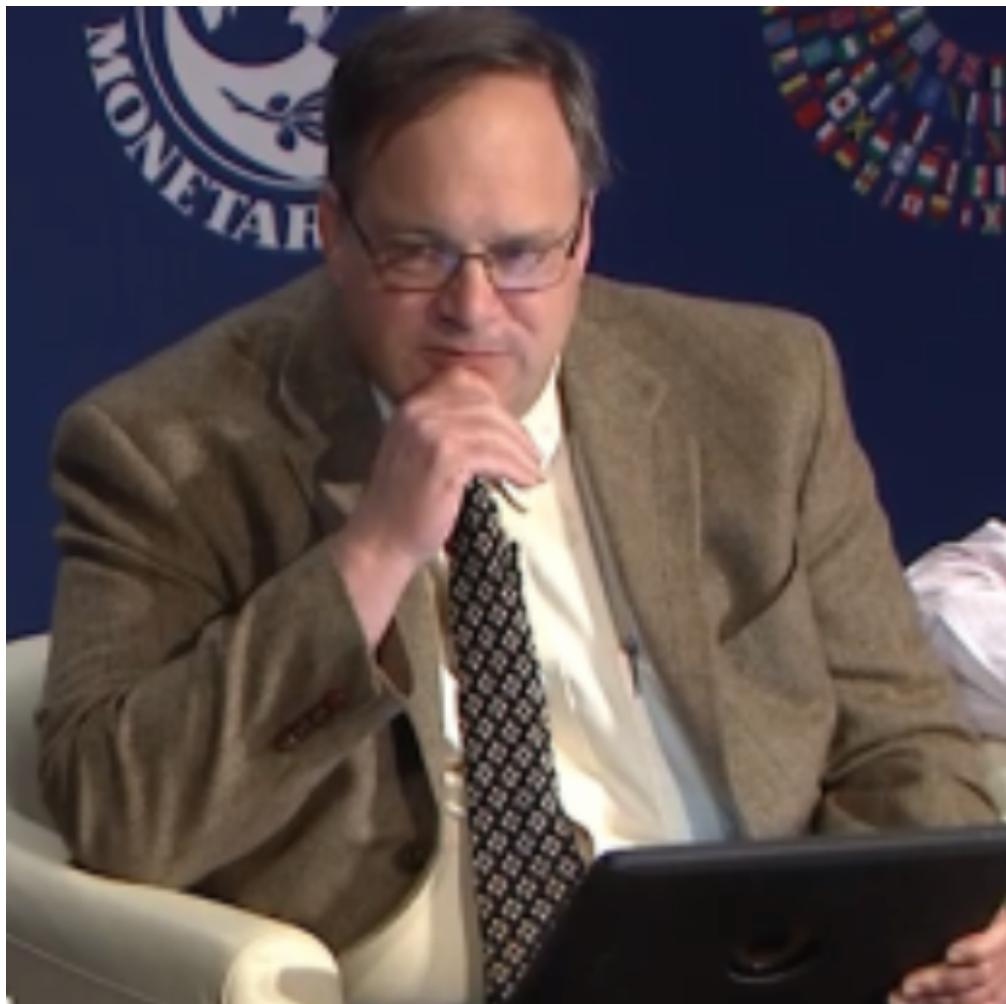
Enormous changes in relative prices:

- A short book today trades for 2 lb. of flour
- At 25 X for 100 lines, a short book in the time of Diocletian traded for 250 lb. of flour
 - And the same in the time of Martial: 1 HS/page (note the 40-to-1 inflation)
 - General labor wage then: 2.5 lbs. flour/day...
 - General labor wage now: 120 lbs. flour/day
- I have 1000 physical books in my sight right now—that's enough flour in the time of Diocletian or Martial to feed 3 cohorts of the imperial Roman army for a year
- Plus there are all the books I have at my virtual fingertips...
- Standard statistics say we are only 15 times as rich...
 - On the physical book standard, a typical California annual household income today would pay the wages of 1,500 men for a year.
 - On the wheat flour standard, a typical California annual household income today would pay the wages of 50 men for a year.
 - On the unskilled labor standard, a typical California annual household income today would pay the wages of two unskilled servants for a year.



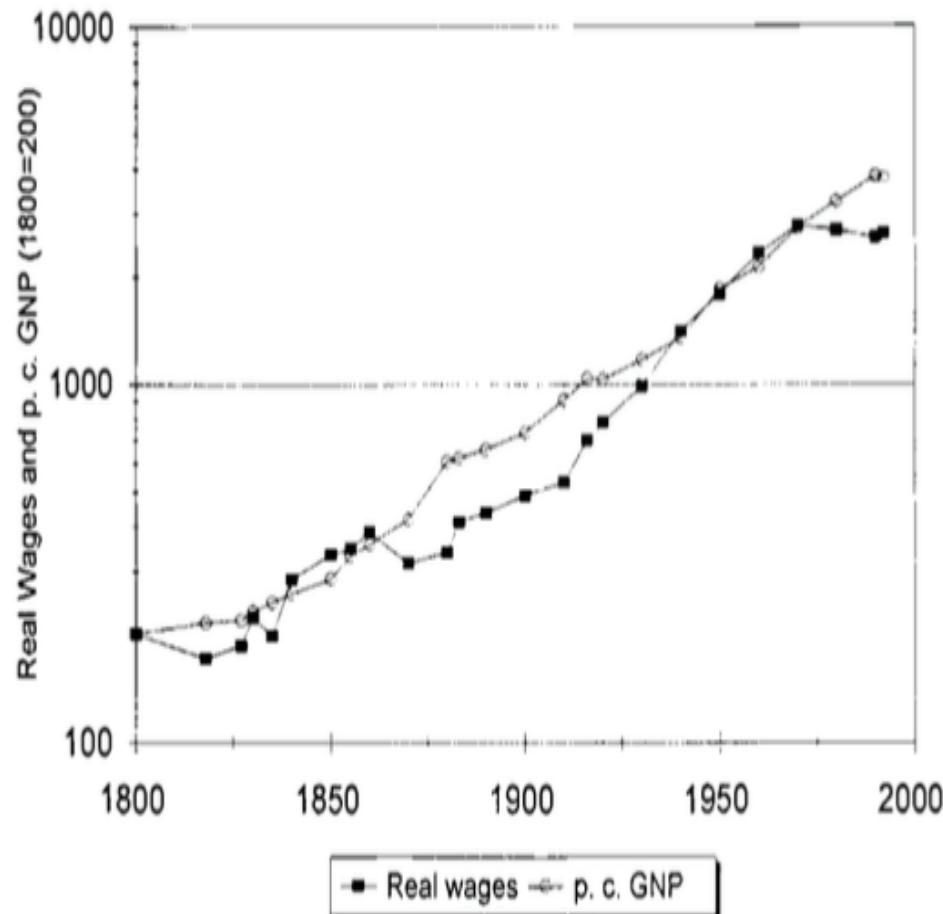
Catch Our Breath...

- Ask a couple of questions?
- Make a couple of comments?
- Any more readings to recommend?



Bill Nordhaus: History of Lighting

- William D. Nordhaus. 1997. “Do Real-Output and Real-Wage Measures Capture Reality? The History of Lighting Suggests No In *The Economics of New Goods* edited by Timothy F. Bresnahan and Robert J. Gordon. Chicago: University of Chicago Press for NBER, pp. 29– 66. <http://www.nber.org/chapters/c6064>
- Conventional measures: a 15-fold increase in real first-world GDP/capita and productivity



Bill Nordhaus: Rocket Ship to the Singularity?

- A 20-fold or a 30,000-fold increase in real wages in the North Atlantic since 1800?
- Nordhaus calculates that—back in 1991—28% of consumption was “run-of-the-mill”, 36% had been “seismically-active” since 1800, and 37% was in sectors that had *no effective affordable equivalent in 1800*
- Dixit-Stiglitz tells us that we multiply “ordinary” utilities by the number of varieties. Which way does that mislead us?

Table 1.8 Consumption by Extent of Qualitative Changes, 1991 (\$ billion)

Sector	Run-of-the-Mill Sectors	Seismically Active Sectors	Tectonically Shifting Sectors
Food			
Home consumption	419.2		
Purchased meals		198.5	
Tobacco		47.8	
Clothing			
Apparel	208.9		
Cleaning and services		21.1	
Watches and jewelry		30.6	
Personal care			
Toilet articles		38.2	
Services	24.0		
Housing			
Dwellings		574.0	
Housing operation			
Furniture and utensils	116.3		
Appliances		25.5	
Cleaning and polishing		52.8	
Household utilities			143.2
Telephone and telegraph			54.3
Other	49.6		
Medical care			656.0
Personal business			
Legal and funeral	60.3		
Financial and other		257.5	
Transportation			438.2
Recreation			
Printed	42.9		
Toys		32.3	
Electronics and other goods			84.2
Other	51.7	51.2	27.4
Private education and research		92.8	
Religious and welfare	107.7		
Total	1,080.6	1,396.8	1,428.8
Percent of total	27.7	35.8	36.6

Bill Nordhaus: Rocket Ship to the Singularity? II

- A 5000-fold decrease in the price of light since 1800
- This is something that churned up between 1% and 5% of household budgets back in 1800
- 100-fold CPI bias in the price of light since 1800
- How representative is lighting?
- Perhaps 1/3 of what we spend money on produces services in a way that had no reasonable analogue more than two centuries ago

Table 1.3

Efficiency of Different Lighting Technologies

Device	Stage of Technology	Approximate Date	Lighting Efficiency	
			(lumens per watt)	(lumen-hours per 1,000 Btu)
Open fire ^a	Wood	From earliest time	0.00235	0.69
Neolithic lamp ^b	Animal or vegetable fat	38,000–9000 B.C.	0.0151	4.4
Babylonian lamp ^c	Sesame oil	1750 B.C.	0.0597	17.5
Candle ^c	Tallow	1800	0.0757	22.2
	Sperm	1800	0.1009	29.6
	Tallow	1830	0.0757	22.2
	Sperm	1830	0.1009	29.6
Lamp	Whale oil ^d	1815–45	0.1346	39.4
	Silliman's experiment:			
	Sperm oil ^e	1855	0.0784	23.0
	Silliman's experiment:			
	Other oils ^f	1855	0.0575	16.9
Town gas	Early lamp ^g	1827	0.1303	38.2
	Silliman's experiment ^g	1855	0.0833	24.4
	Early lamp ^g	1875–85	0.2464	72.2
	Welsbach mantle ^g	1885–95	0.5914	173.3
Kerosene lamp	Welsbach mantle ^g	1916	0.8685	254.5
	Silliman's experiment ^g	1855	0.0498	14.6
	19th century ^h	1875–85	0.1590	46.6
	Coleman lantern ⁱ	1993	0.3651	107.0
Electric lamp				
Edison carbon	Filament lamp ^j	1883	2.6000	762.0
Advanced carbon	Filament lamp ^j	1900	3.7143	1,088.6
Tungsten	Filament lamp ^j	1910	6.5000	1,905.0
	Filament lamp ^j	1920	11.8182	3,463.7
	Filament lamp ^j	1930	11.8432	3,471.0
	Filament lamp ^j	1940	11.9000	3,487.7
	Filament lamp ^j	1950	11.9250	3,495.0
	Filament lamp ^j	1960	11.9500	3,502.3
	Filament lamp ^j	1970	11.9750	3,509.7
	Filament lamp ^j	1980	12.0000	3,517.0
Compact fluorescent	Filament lamp ^j	1990	14.1667	4,152.0
	First generation bulb ^m	1992	68.2778	20,011.1

Note: The modern unit of illumination is the lumen which is the amount of light cast by a candle at one foot.

Bill Nordhaus & Adam Smith

- Who in the past's life-chances would you have willingly swapped for yours as they stood at birth?
- Adam Smith, TMS:
 - "in the languor of disease and the weariness of old age, the pleasures of the vain and empty distinctions of greatness disappear.... Power and riches appear then to be, what they are, enormous and operose machines contrived to produce a few trifling conveniences to the body... though they may save him from some smaller inconveniences, can protect him from none of the severer inclemencies.... They keep off the summer shower, not the winter storm, but leave him always as much, and sometimes more exposed than before, to anxiety, to fear, and to sorrow; to diseases, to danger, and to death..."
- But that is not really true any more, is it?
- Being so hungry, so cold, so wet that you almost cannot think of anything else is not a big source of disutility any more, is it? And it used to be.
- We are now much less exposed "to sorrow; to diseases, to danger, and to death"
- And they are long delayed...

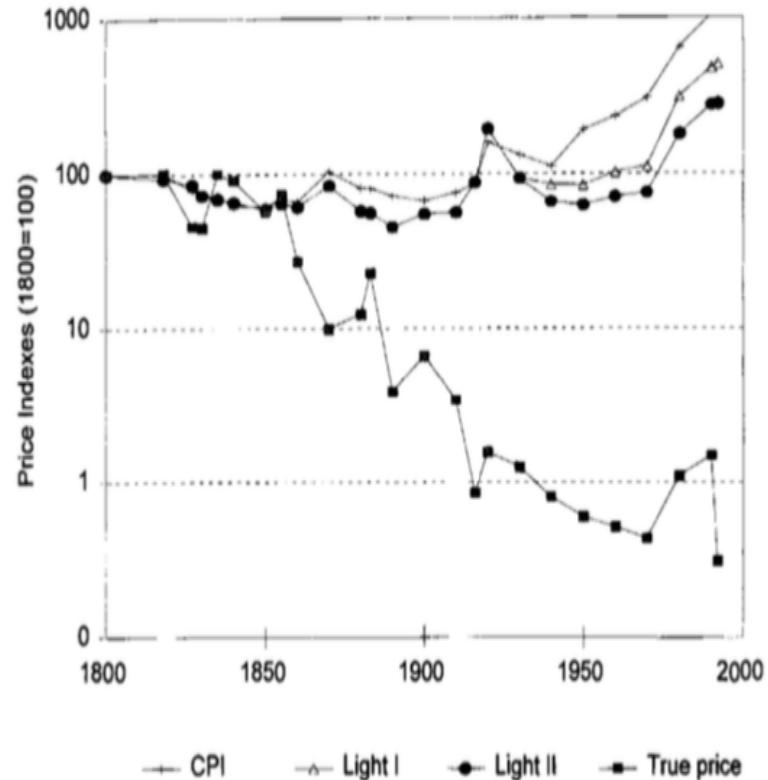


Fig. 1.4 Alternative light prices

Catch Our Breath...

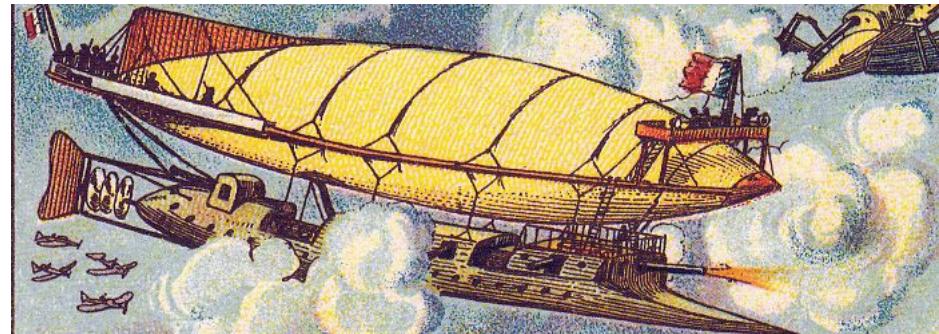
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Keynes's Economic Possibilities for Our Grandchildren

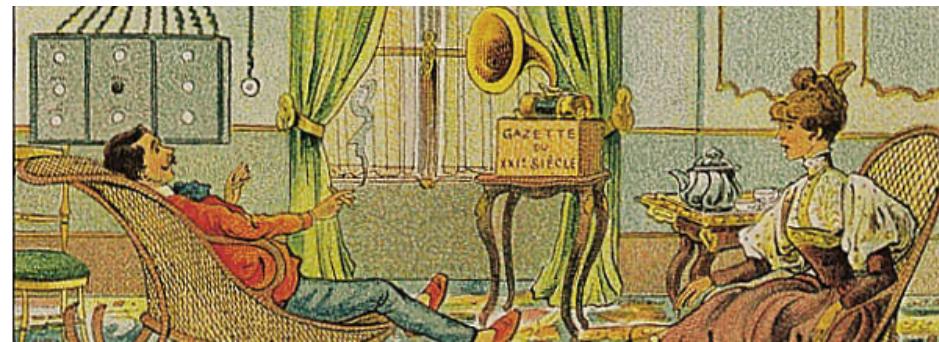
Written in a time of trouble:

- Faulty banking and monetary system
- Preventing the needed decline in the interest rate
- Yet waste and confusion only 7.5% of national income
- Reasonable expectations of life in 2130 are utopian



The pace of progress depended on:

1. The demographic transition
 2. International and civil war
 3. Science!
 4. Investment
-
- Lack of pre-1700 progress due to lack of technology and lack of investment
 - Now we have both



Here We Have Keynes Being Very Wrong

“Almost everything which really matters... [in 1770] was already known... at the dawn of history...”:

- “...Language, fire, the same domestic animals which we have to-day, wheat, barley, the vine and the olive, the plough, the wheel, the oar, the sail, leather, linen and cloth, bricks and pots, gold and silver, copper, tin, and lead—and iron was added to the list before 1000 B.C.—banking, statecraft, mathematics, astronomy, and religion...”
- But: H from 1 (70K years ago) to 5 (10k years ago) to 17 (3K years ago) to 53 in 1500, 79 in 1770, 123 in 1870, 2720 today
- Or is Keynes wrong—especially as he starts with “language, fire”?



George Bernard Shaw & John Maynard Keynes leaving Cambridge, England's Fitzwilliam Museum in the mid-1930s

The Force of Exponential Growth

In the long run mankind is solving the economic problem:

- A standard of life in 2030 four to eight times higher than seen in 1930...
- Absolute needs are satiable...
 - And should be satiated sooner than most of us expect
- The relative need for superiority may well be insatiable...
- The economic problem has been humanity's biggest problem for all of history:
 - So people have worked hard to be more productive
 - So people have figured out how to take stuff from others
- What will life be like after the economic problem?

After the Economic Problem

Keynes has reflections:

- Our impulses, our instincts, and our institutions are all built to deal—one way or another—with the economic problem
- Is there a problem in how people will find meaning in their lives when the spur of necessity is no longer there to make people feel useful?
- Man will be faced with his real, his permanent problem:
- How to use his freedom which science and compound interest will have won for him
- How to live wisely and agreeably and well.
- To judge from the behaviour and the achievements of the wealthy classes to-day in any quarter of the world, the outlook is very depressing!
- “I see us free... [to] once more value ends above means and prefer the good to the useful... honour those who can teach us how to pluck the hour and the day virtuously and well...”
- “But beware!... For at least another hundred years... foul is useful and fair is not:
- Avarice and usury and precaution must be our gods for a little longer still
- Only they can lead us out of the tunnel of economic necessity into daylight

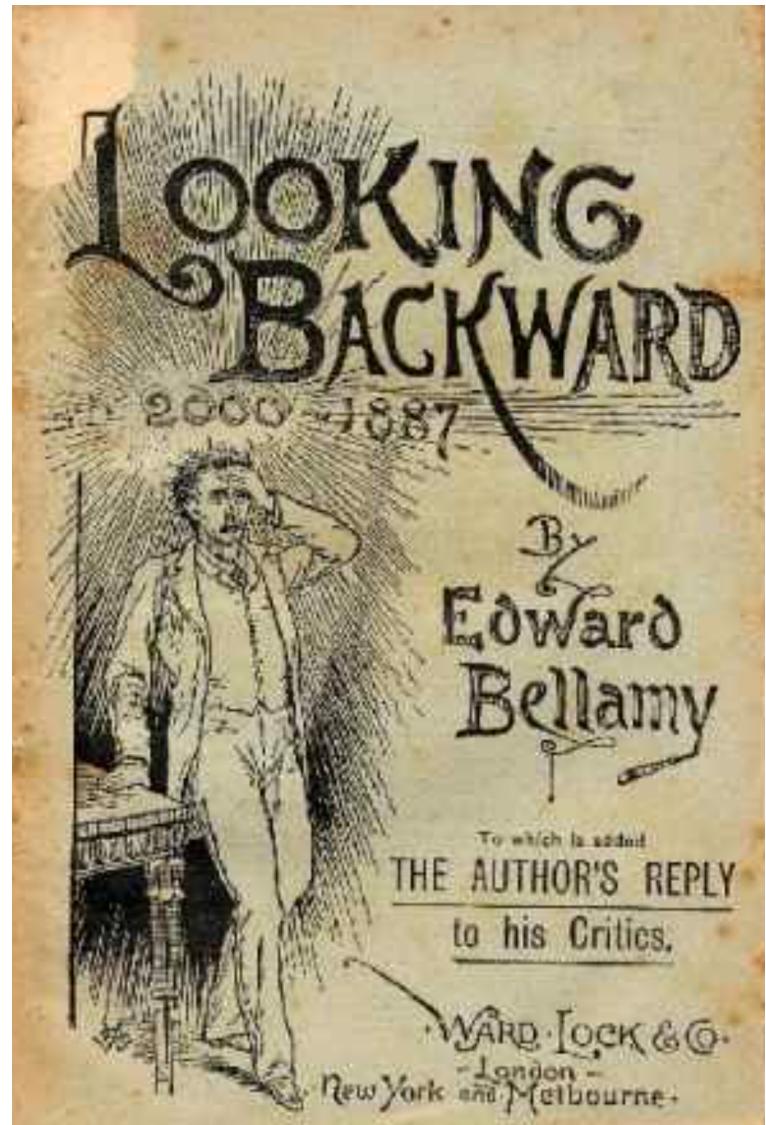
Catch Our Breath...

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“Do You Like Music?”

- Perhaps a better way to approach this question...
- *Looking Backward*, Edward Bellamy's 1887 utopian novel.
- Narrator in 2000 hears the question (p. 87): “Are you fond of music?”
 - He expects his hostess to play the piano—a social accomplishment of upper-class women around 1900.
 - It would have cost the average worker roughly a year at a 50-hour workweek to earn the money to buy a high-quality piano,
 - And then there would be the expense and the time committed to piano lessons.
- But today, to listen to music-on-demand in your home, all you need is... your smartphone...



Labor-Time Values

- A Steinway piano labor-time price:
 - 2400 average worker-hours in 1870
 - 1000 average worker-hours today.
- But the capability of listening to music at home:
 - 2400 average worker-hours a century ago
 - What today? 5 hours?
 - And then there is variety, and quality
- x 2 or x 500?

arsTECHNICA BIZ & IT TECH SCIENCE POLICY CARS GAMING & CULTURE FOOD

IFIXIT — iFixit's iPhone XS and XS Max teardown: Like the iPhone X with a couple surprises

The iPhone XS has a wild new battery design.

SAMUEL AXON - 9/21/2018, 10:40 AM



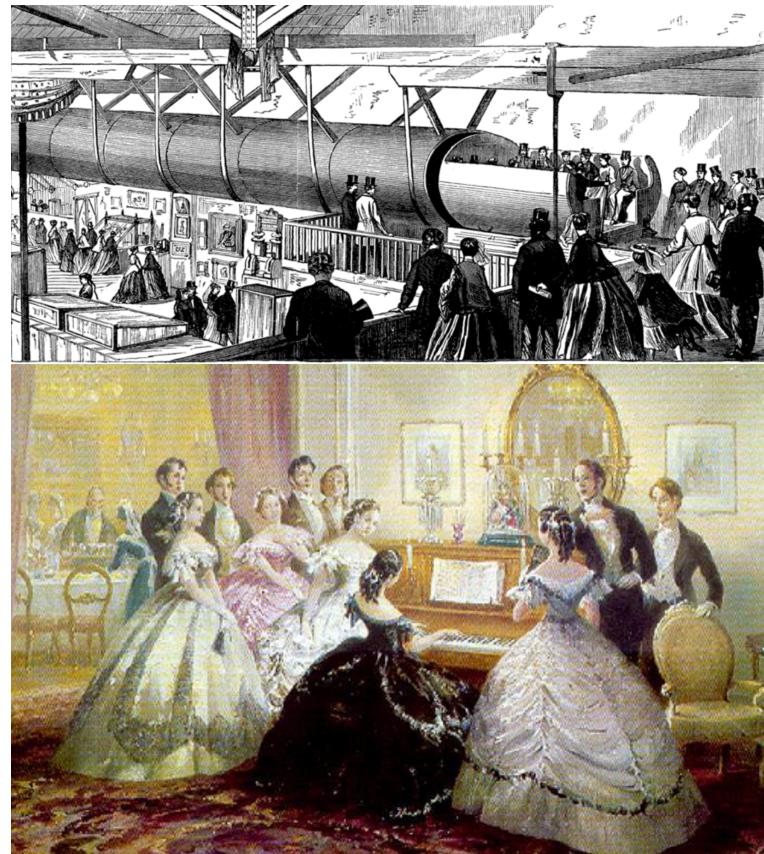
The iPhone XS has a different battery design than the iPhone XS Max, which has the same design as the iPhone X.

When we went hands-on with the iPhone XS and XS Max, we were mainly struck by how similar they felt to the iPhone X—particularly the iPhone XS. But it turns out that inside, it's the iPhone XS that diverges with an unusual new battery design. iFixit tore down both phones and provided analysis and gorgeous pictures as always. Be sure to check out their full teardown, but a few highlights stand out.

Let's be clear: both of these phones are the iPhone X.

“The Limit of Human Felicity...”

- Bellamy's protagonist in the year 2000 is then stupefied
- His hostess “merely touched one or two screws...”
- She calls the orchestra and puts it on the speakerphone.
- Bellamy's protagonist then says (p. 90):
 - If we [in the 1800s] could have devised an arrangement for providing everybody with music in their homes, perfect in quality, unlimited in quantity, suited to every mood, and beginning and ceasing at will, we should have considered the limit of human felicity already attained...
- To Edward Bellamy—a self-described utopian visionary—a radio that could tune into any of four stations is “the limit of human felicity.”



Tower Records

- What if someone were to take Edward Bellamy to Tower Records?
- Ooops.
- Well, if we could have taken Edward Bellamy to Tower Records when it existed, his heart would have stopped.
- And now?
- Yet we do not think of our modern ability to cheaply listen to high-fidelity go-anywhere listen-to-anything music as a remarkable or even a notable part of our economy. We did not daily give thanks for our CD collections—back when we had CD collections.
- We in the North Atlantic today do not reflect that via our smartphone music functions we have been brought to “the limit of human felicity...”
- But Edward Bellamy would think that we have...



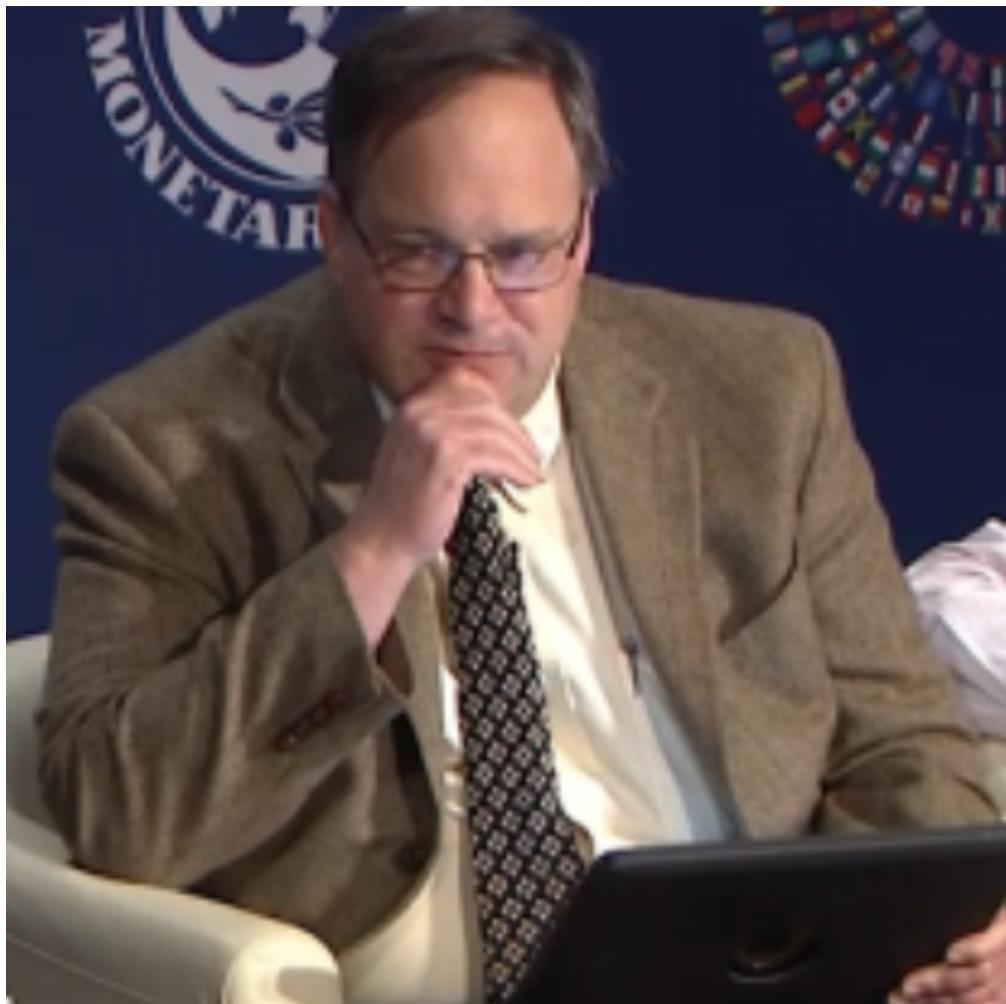
William Nordhaus, Not Quite Among the 400, and Nathan Meyer Rothschild

- We have been brought back to William Nordhaus's argument that our commodity-focused price indices miss most of the real action
- Nordhaus guesses that standard estimates understate "true" economic growth since 1800 by between 0.5% and 1.4% per year
- An amount that cumulates to a multiplicative factor of between 3 and 21 over the past two centuries
- In addition to the 16-fold increase of standard statistics
- A factor between 50 and 350.
- Is this credible?
- I have no problem at all with it...
 - The death of Nathan Meyer Rothschild
- Making the switch...



Catch Our Breath...

- Ask a couple of questions?
- Make a couple of comments?
- Any more readings to recommend?



Big Ideas: Lecture 26: The Pace and Meaning of Economic Growth

Takeaways from this lecture:

Roadmap...

7. Conclusion

27. Th May 7: 7.1. The Future?

- **Read Before:** Robert Allen (2011): Global Economic History: A Very Short Introduction, selections <<https://delong.typepad.com/files/allen-geh.pdf>>

Catch Our Breath...

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Notes, etc....



Coronavirus!

Members of the public were told to avoid gatherings of 10 or more



ABC News



Trump warns coronavirus crisis could stretch into summer

Watch

Members of the public were told to avoid gatherings of 10 or more and older people and those with underlying condition were asked to stay home.

Coronavirus

Where we think we are, as of Th Apr 09:

- We really do not know
- No random samples...
- If we extrapolate out the past week straight-line log:
 - We will have 440,000 deaths in three weeks
 - But it is unlikely to be that bad
- Best thing I have read comes from Jim Stock <<https://drive.google.com/file/d/12MV466ZZy5xHir4xdPhoTrL1oQ8CbZU-/view>>:
 - The basic SIR epidemiological model of contagion
 - The effect of social distancing and business shutdowns on epidemic dynamics enters the model through a single parameter: the case transmission rate β
 - Re-express the model in terms of β and the asymptomatic (or not very symptomatic) hence non-tested rate—the fraction of the infected who are not tested
 - The COVID-19 non-testing rate is unidentified in our model
 - Estimates in the epidemiological literature range from 0.18 to 0.86.
 - The asymptomatic rate could be estimated accurately and quickly by testing a random sample
 - The optimal policy response and its economic consequences hinge critically on the asymptomatic rate

Coronavirus Extrapolations						
Date	Deaths	Cases = Deaths x 100	Constant Weekly New Cases	Cases = 5 x Cases(-3)	Cases = 20 x Cases (-3)	Cases = Cases (-3) x exp(3 x week ch)
2020-04-05	9618		3,102,000	4,809,000	19,236,000	55,832,145
2020-03-29	2484		869,400	1,242,000	4,968,000	53,654,400
2020-03-22	414		144,900	207,000	828,000	8,942,400
2020-03-15	69	961,800	19,800	34,500	138,000	128,966
2020-03-08	26	248,400	10,100	13,000	52,000	45,697,600
2020-03-01	1	41,400	370	500	2,000	100,000
2020-02-23		6,900	37	50	200	10,000
2020-02-16		2,600	4	5	20	
2020-02-09		100				
2020-02-02		10				
2020-01-26		1				
		0				

<https://www.incloud.com/numbers/0FzRFAnAOnIAin4VJWWiWIC0>

Coronavirus Cases:  United States

1,342,235

[view by country](#)

Coronavirus Cases:

364,059

Deaths:

74,554

Deaths:

10,792

Recovered:

278,182

Recovered:

19,536

USA State	Tot Cases/ 1M pop	Deaths/ 1M pop
USA Total	1,100	33
New York	6,662	243
New Jersey	4,626	113
Michigan	1,729	73
California	404	10
Louisiana	3,188	110
Massachusetts	2,026	38
Florida	662	12
Pennsylvania	1,016	13
Illinois	956	24
Washington	1,095	46
Texas	263	5
Georgia	710	22

Coronavirus II

We do not really know where we are, as of Mo Apr 6:

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2020-02-16		2,600	4	5	20	
2020-02-09		100				
2020-02-02		10				
2020-01-26		1				
		0				

<https://www.incloud.com/numbers/0FzRFArAOnIAin4VJWWiWIC0>

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2020-03-15	69	961,800	19,800	34,500	138,000	128,966
2020-03-08	26	248,400	10,100	13,000	52,000	45,697,600
2020-03-01	1	41,400	370	500	2,000	100,000
2020-02-23		6,900	37	50	200	10,000
2020-02-16		2,600	4	5	20	
2020-02-09		100				
2020-02-02		10				
2020-01-26		1				
		0				

<https://www.icloud.com/numbers/0FzRFAoAQoiAin4V.IWYWIWICQ>

Coronavirus Case



United States

1,342,235

[view by country](#)

Coronavirus Cases:

364,059

Deaths:

74,554

Deaths:

10,792

Recovered:

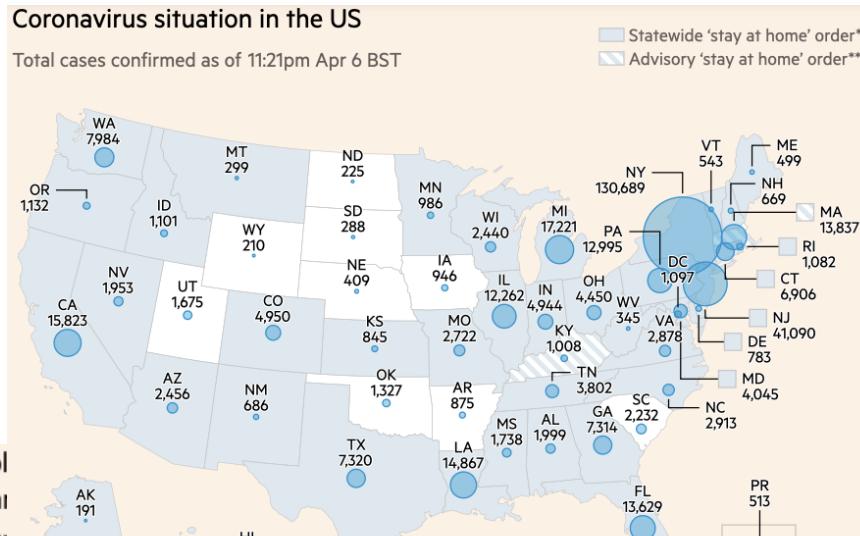
278,182

Recovered:

19,536

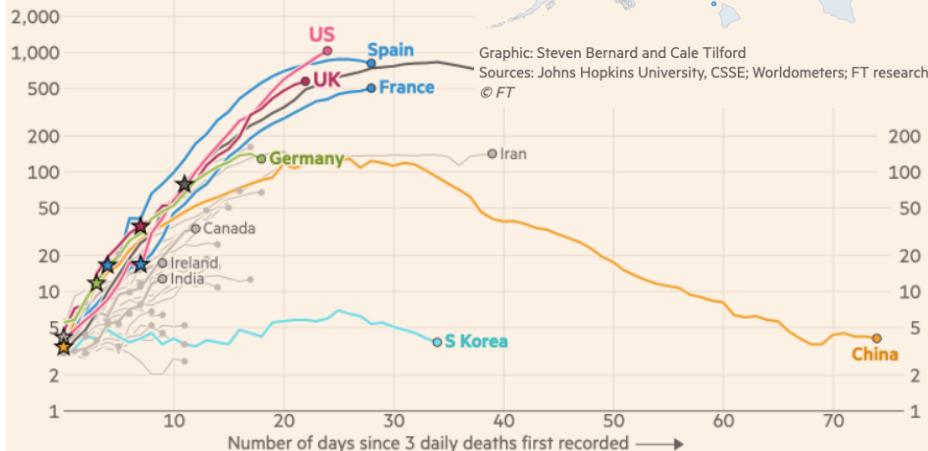
USA State	Tot Cases/ 1M pop	Deaths/ 1M pop
USA Total	1,100	33
New York	6,662	243
New Jersey	4,626	113
Michigan	1,729	73
California	404	10
Louisiana	3,188	110
Massachusetts	2,026	38
Florida	662	12
Pennsylvania	1,016	13
Illinois	956	24
Washington	1,095	46
Texas	263	5
Georgia	710	22

Financial Times Graphs Blown Up...



Italy and Spain's daily death tolls are plateauing, while the US and UK are still rising.
 every day brings more new deaths than the day before.

Daily coronavirus deaths (7-day rolling avg.), by number of days since 30 daily cases first recorded



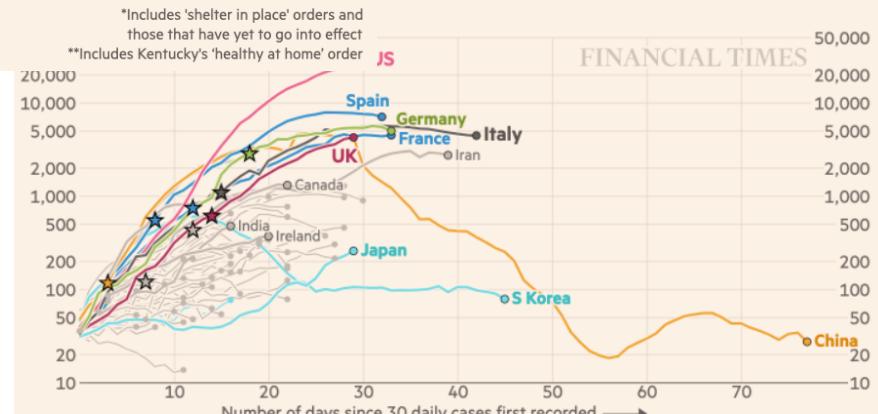
FT graphic: John Burn-Murdoch / @jburnmurdoch

Source: FT analysis of European Centre for Disease Prevention and Control; Worldometers; FT research. Data updated April 06, 19:00 GMT

© FT

numbers of new cases now in decline,

by number of days since 30 daily cases first recorded



FT graphic: John Burn-Murdoch / @jburnmurdoch

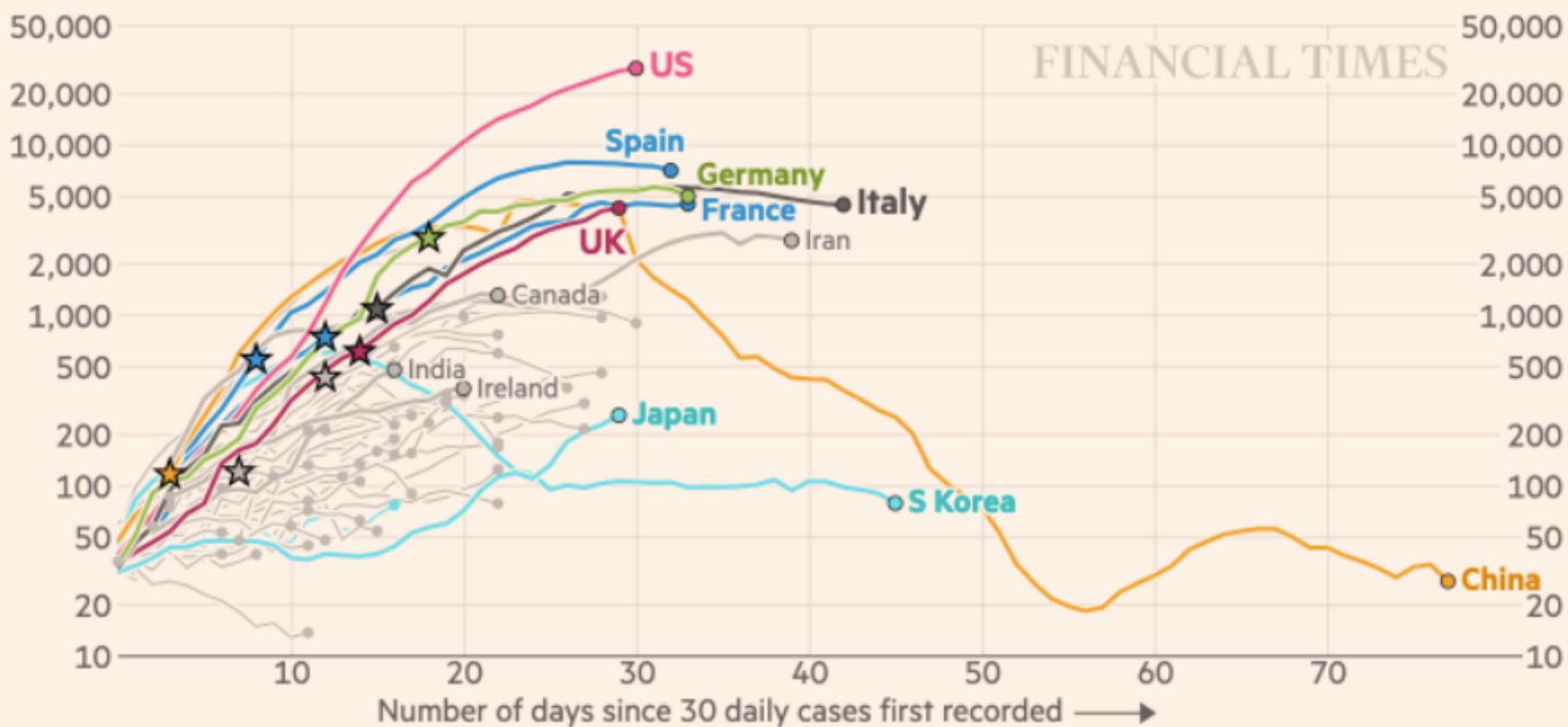
Source: FT analysis of European Centre for Disease Prevention and Control; Worldometers; FT research. Data updated April 06, 19:00 GMT

© FT

Italy has turned the corner, with numbers of new cases now in decline, following in China's footsteps

Daily confirmed cases (7-day rolling avg.), by number of days since 30 daily cases first recorded

Stars represent national lockdowns ★



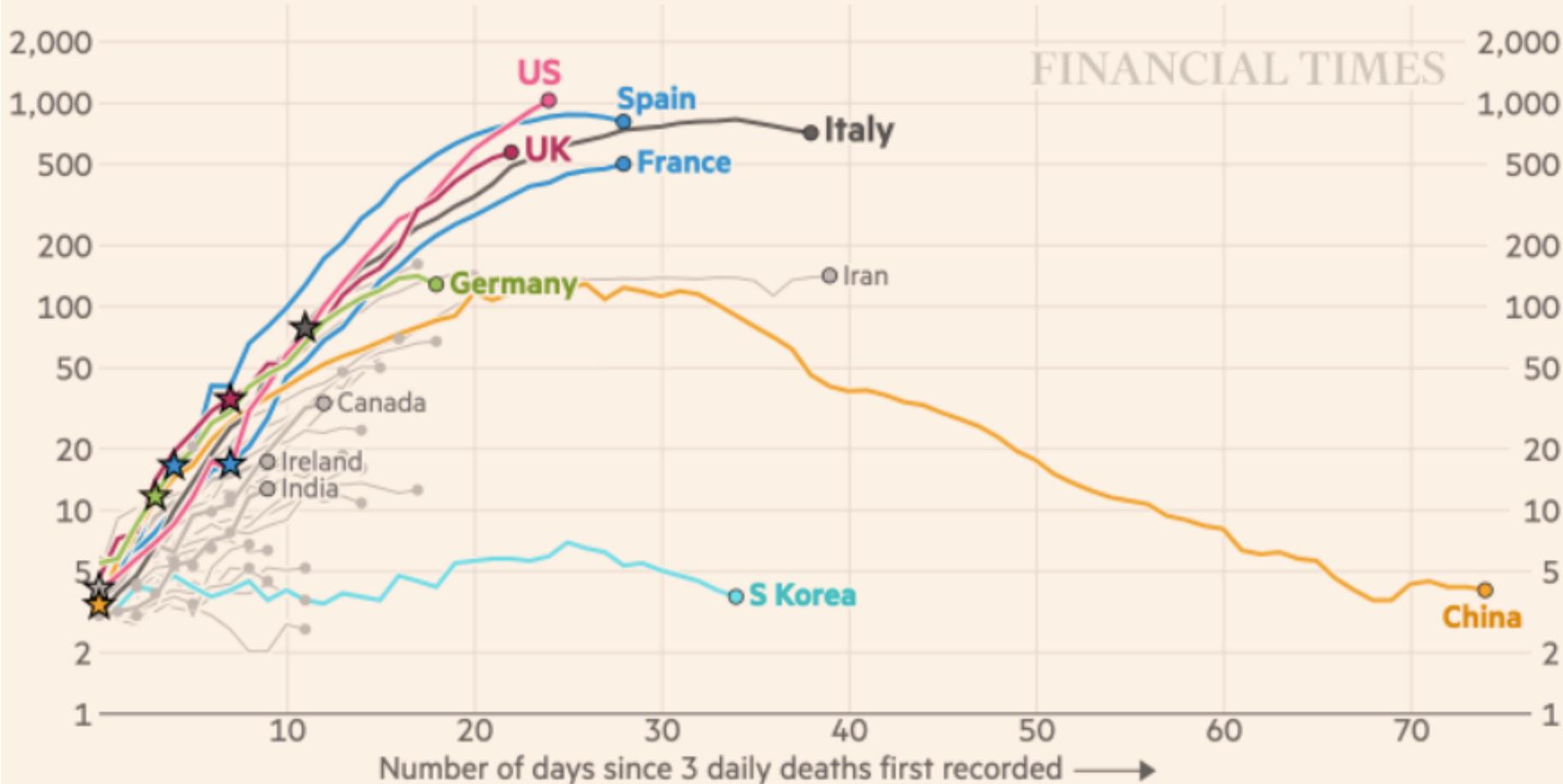
FT graphic: John Burn-Murdoch / @jburnmurdoch

Source: FT analysis of European Centre for Disease Prevention and Control; Worldometers; FT research. Data updated April 06, 19:00 GMT

© FT

Italy and Spain's daily death tolls are plateauing, but in the UK and US every day brings more new deaths than the last

Daily coronavirus deaths (7-day rolling avg.), by number of days since 3 daily deaths first recorded



FT graphic: John Burn-Murdoch / @jburnmurdoch

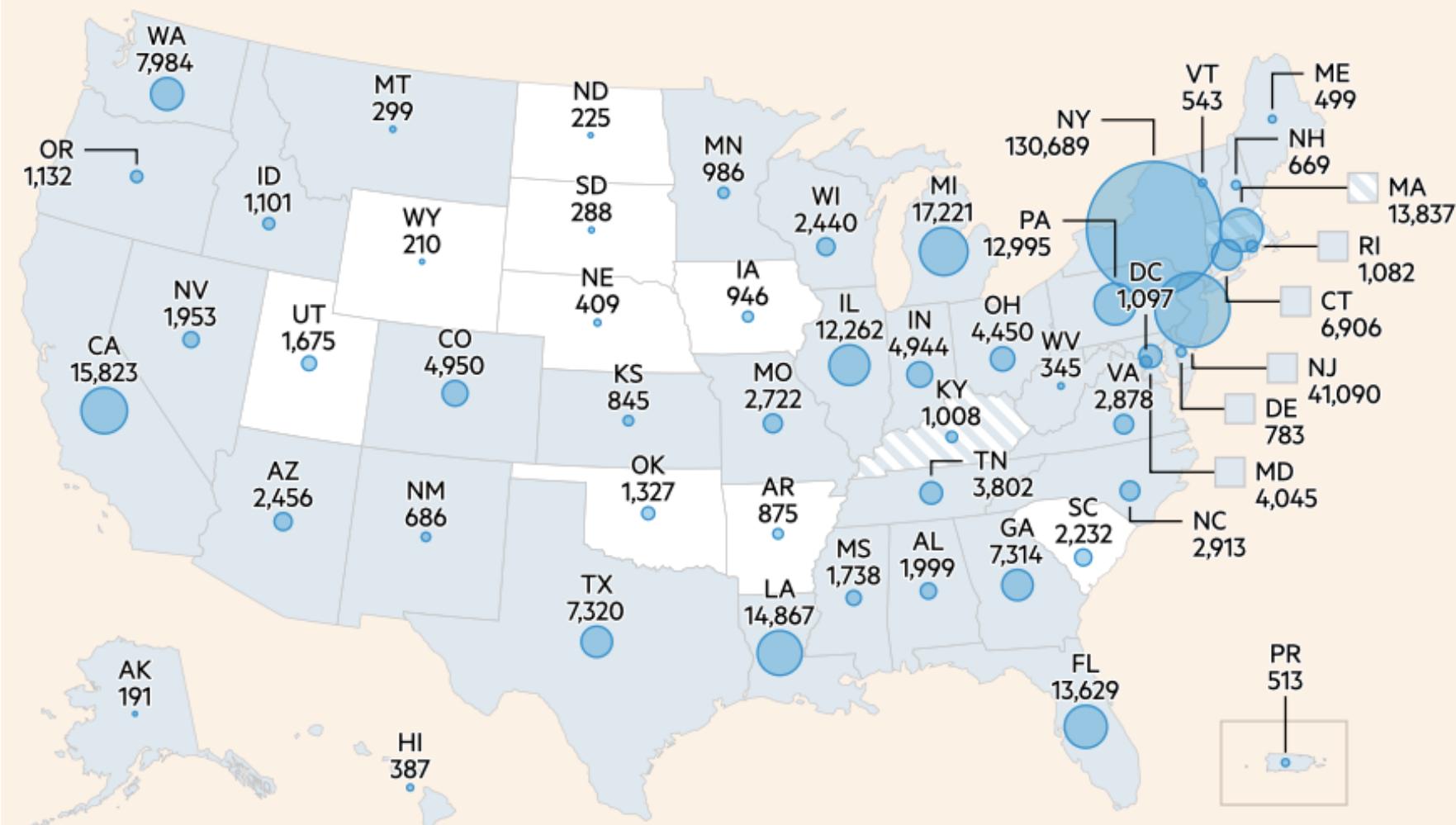
Source: FT analysis of European Centre for Disease Prevention and Control; Worldometers; FT research. Data updated April 06, 19:00 GMT

© FT

Coronavirus situation in the US

Total cases confirmed as of 11:21pm Apr 6 BST

- Statewide 'stay at home' order*
- Advisory 'stay at home' order**



Graphic: Steven Bernard and Cale Tilford

Sources: Johns Hopkins University, CSSE; Worldometers; FT research

© FT

*Includes 'shelter in place' orders and those that have yet to go into effect

**Includes Kentucky's 'healthy at home' order

James Stock (2020)

Standard SIR model: <<https://drive.google.com/file/d/12MV466ZZy5xHir4xdPhoTrL1oO8CbZU-/view>>:

- Susceptible, Infected, Recovered (& immune), transmission rate β , recovery rate γ , reproduction number R_0 , asymptomatic hence non-tested rate π_0
- Calibration: half-life of infection one week: $\gamma = 0.5$, $s_0 = 0.02$, 50 cases on Jan 24
- For March 21, 2020, the positive test rate in the United States is approximately 10%...

$$\Delta S_t = -\beta I_{t-1} \frac{S_{t-1}}{N}$$

$$\Delta R_t = \gamma I_{t-1},$$

$$\Delta I_t = \beta I_{t-1} \frac{S_{t-1}}{N} - \gamma I_{t-1}$$

<<https://drive.google.com/file/d/12MV466ZZy5xHir4xdPhoTrL1oO8CbZU-/view>>

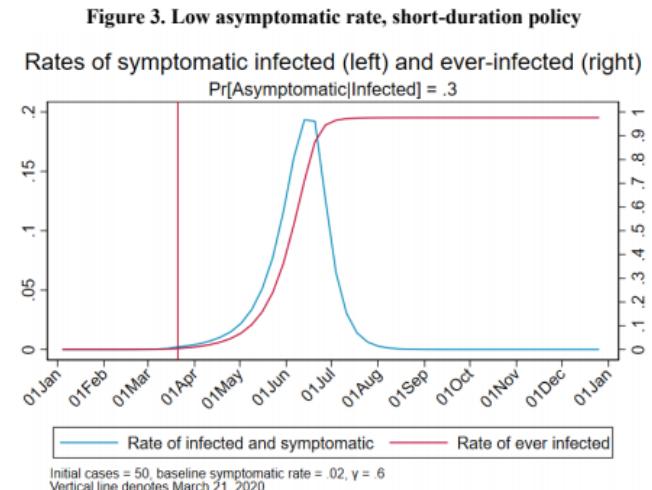


Figure 2. High asymptomatic rate, short-duration policy

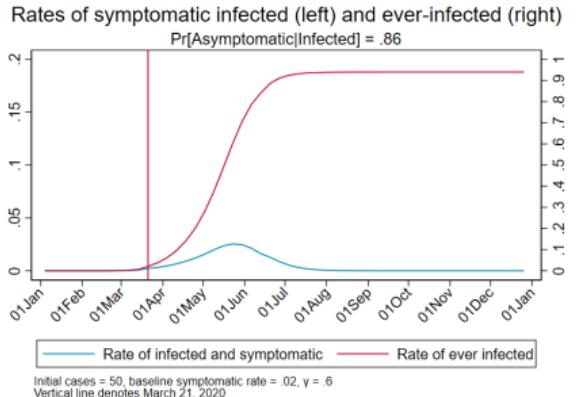


Figure 4. Low asymptomatic rate, severe long-duration policy

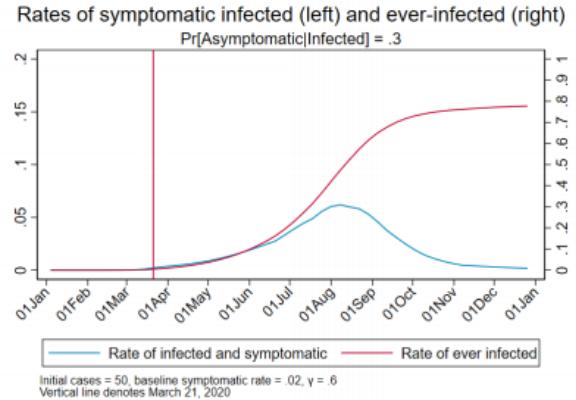
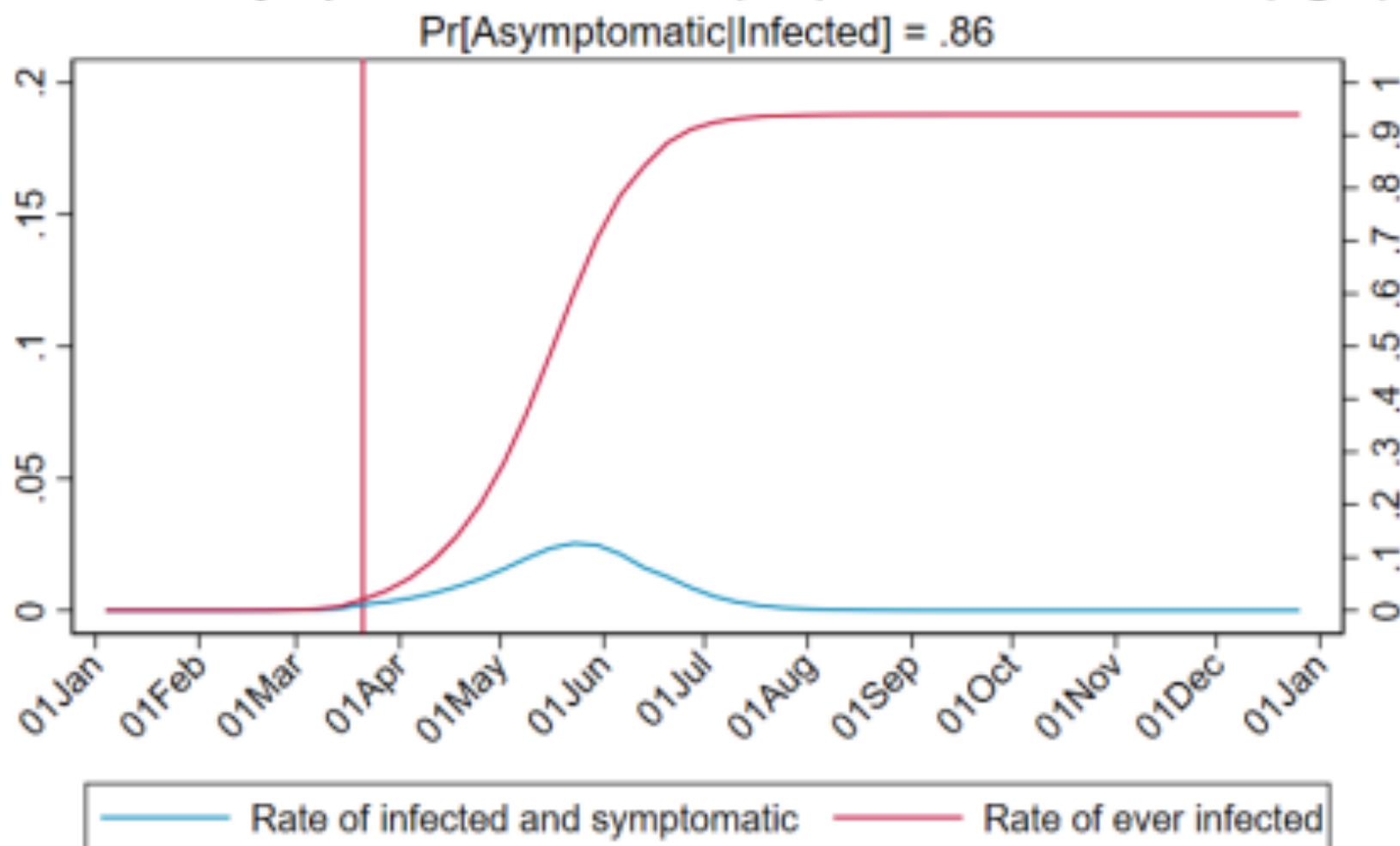


Figure 2. High asymptomatic rate, short-duration policy

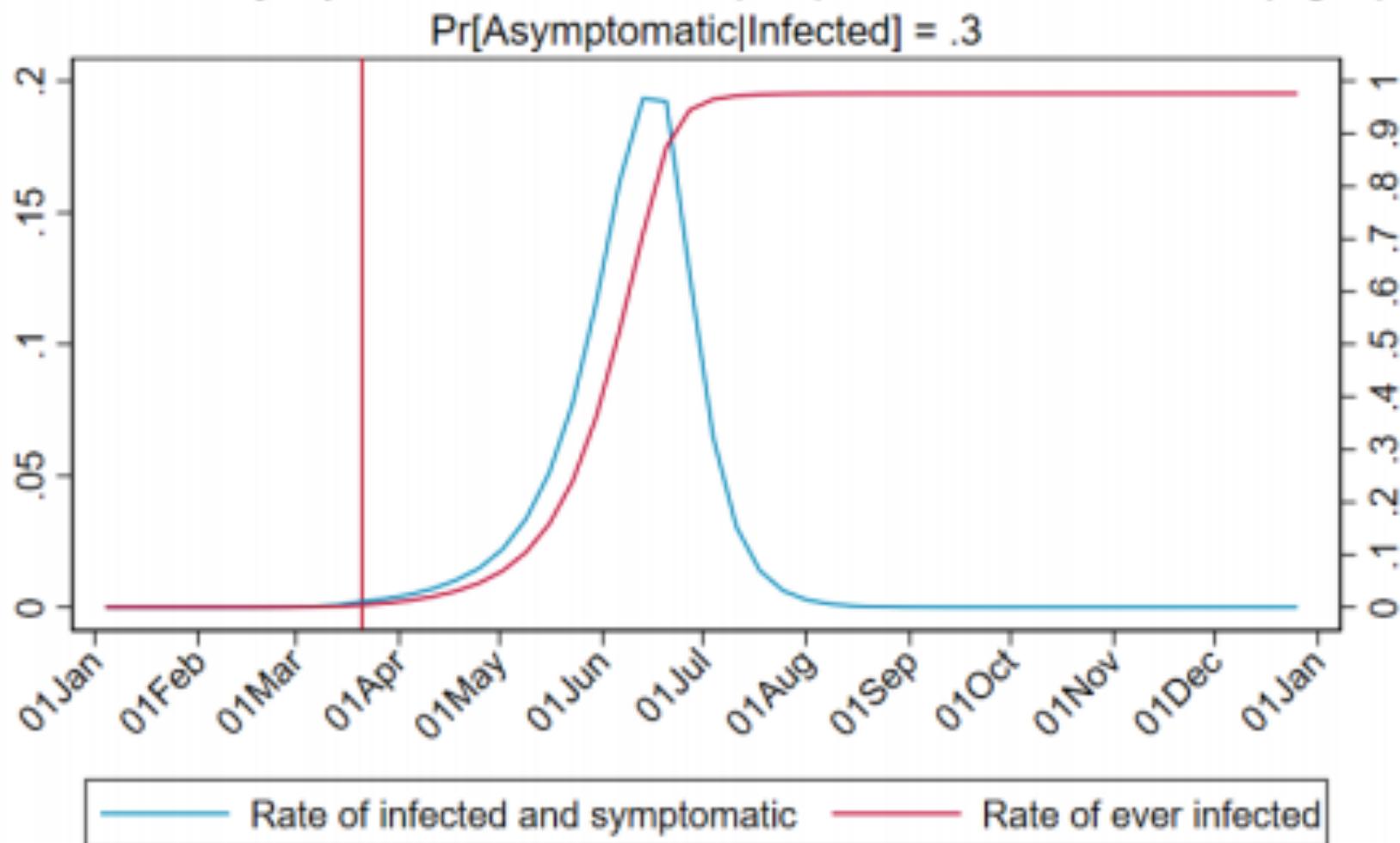
Rates of symptomatic infected (left) and ever-infected (right)



Initial cases = 50, baseline symptomatic rate = .02, $\gamma = .6$
Vertical line denotes March 21, 2020

Figure 3. Low asymptomatic rate, short-duration policy

Rates of symptomatic infected (left) and ever-infected (right)

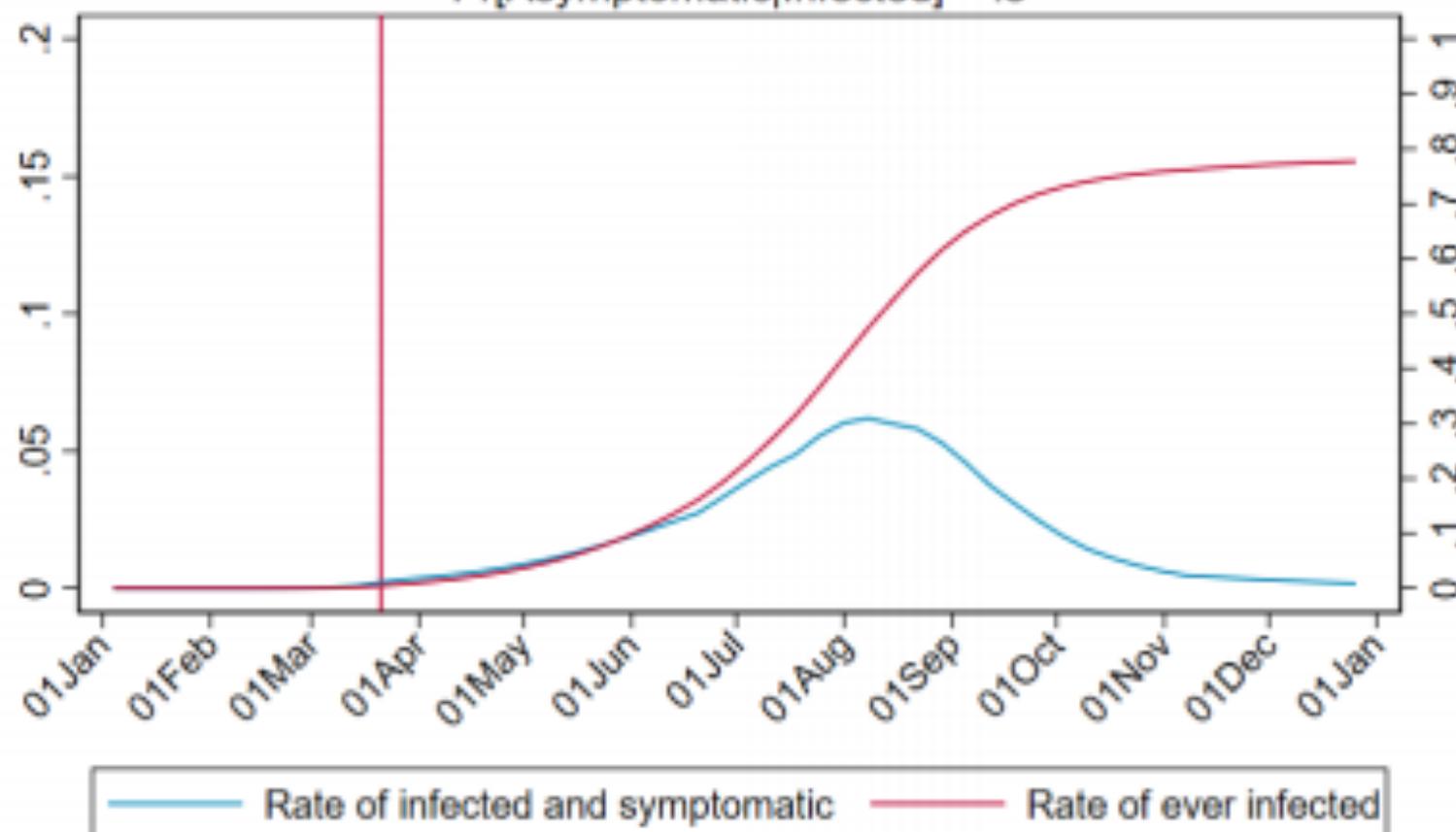


Initial cases = 50, baseline symptomatic rate = .02, $\gamma = .6$
Vertical line denotes March 21, 2020

Figure 4. Low asymptomatic rate, severe long-duration policy

Rates of symptomatic infected (left) and ever-infected (right)

$$\Pr[\text{Asymptomatic} | \text{Infected}] = .3$$



Initial cases = 50, baseline symptomatic rate = .02, $\gamma = .6$
Vertical line denotes March 21, 2020

$$\Delta S_t = -\beta I_{t-1} \frac{S_{t-1}}{N}$$

$$\Delta R_t = \gamma I_{t-1},$$

$$\Delta I_t = \beta I_{t-1} \frac{S_{t-1}}{N} - \gamma I_{t-1}$$

Bringing the Economy Back Up from Anæsthesia

Major issues:

- Certificates of immunity:
 - Which requires test, test, test:
 - And not just disease virus tests
 - Presence-of-antibodies tests
- How quickly can we match the immune with public-contact jobs?
- What jobs can be done with minimal infection risk?
- What minimal-infection substitutes can we find for previous jobs?
- How quickly can restrictions be relaxed without the virus coming roaring back?
- How do we avoid having the market give a “shutdown” signal to enterprises we in fact want restarted?
 - Which is pretty much all of them
- How much of the potential caseload do we want to push out beyond the vaccine-arrival date?

ALL THESE QUESTIONS ARE ANSWERABLE IF WE LEARN THE ASYMPTOMATIC HENCE NON-TESTED RATE!!

Keeping the Economy from Crashing During the Lockdown

Nick Rowe: We have a 50% output cut in 100% of the sectors:

- A temporary 100% output cut in 50% of the sectors (what the Coronavirus does) is very different from a 50% output cut in 100% of the sectors
- Nick's thought experiment:
 - In three months we are going to invent unobtanium:
 - Substantial intertemporal substitutability
 - Plus lower cross-good contemporaneous substitutability
 - Hence high desired savings rate now
 - Flex-price market thus produces a nominal rate at the zero lower bound and a high inflation rate over the next three to six months
 - Plus liquidity-constrained workers in affected sectors see their demand go to zero immediately
 - Can we get there? Should we get there? What should we do instead?
 - We need a good RBC economist: are there any?...

Keeping the Economy from Crashing During the Lockdown II

Nick Rowe:

- <https://worthwhile.typepad.com/worthwhile_canadian_initi/2020/03/relative-supply-shocks-unobtainium-walras-law-and-the-coronavirus.html>
- Plus: to extend the thought experiment:
 - We just lost the ability to make “unobtainium”
 - So we *should* be substituting leisure for work, and moving workers into relatively unproductive labor, making the commodities we can still produce right now
 - How should relative prices move as a result? How should we make them move?

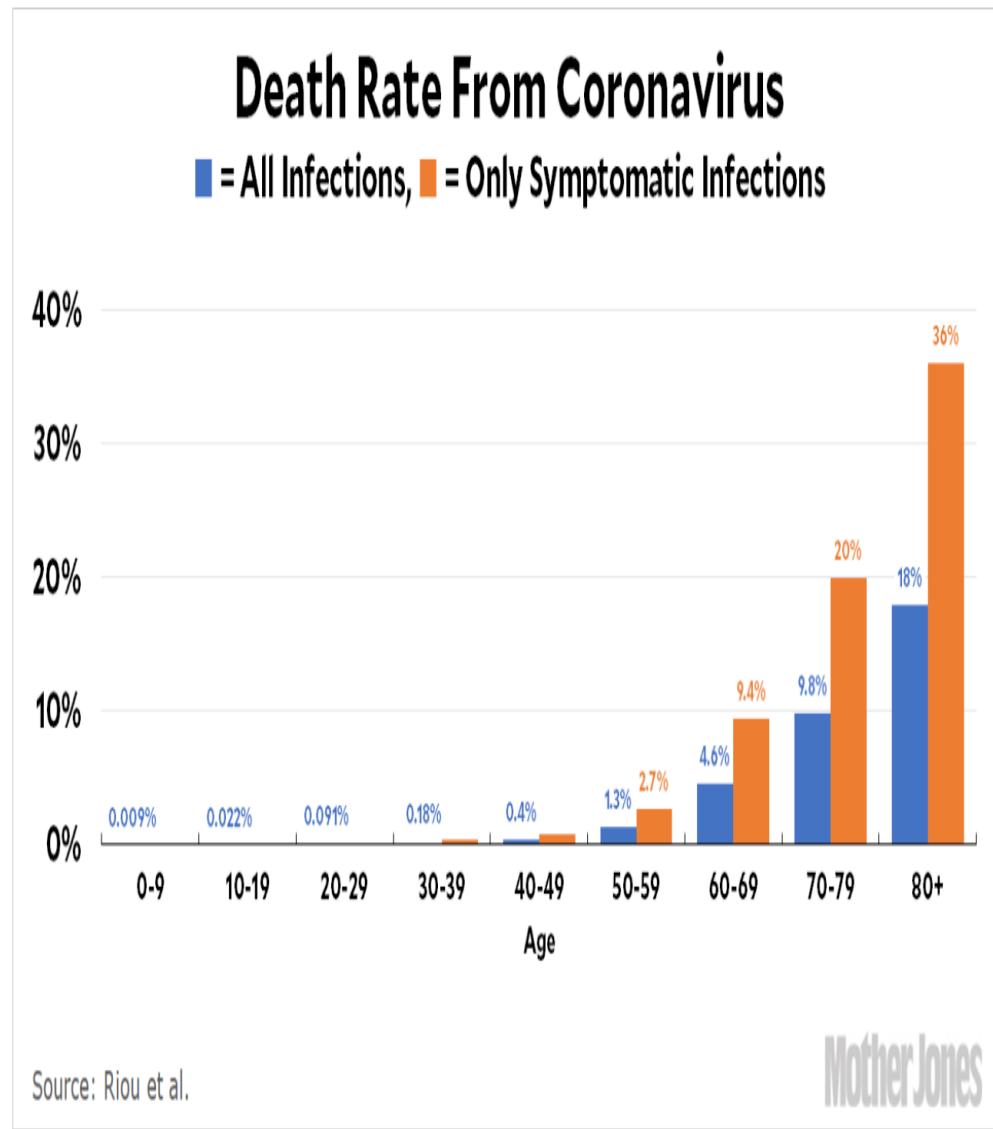
Plus: distributional issues

Plus: bankruptcy and credit chain issues

MOAR Coronavirus!

Death for Geezers!

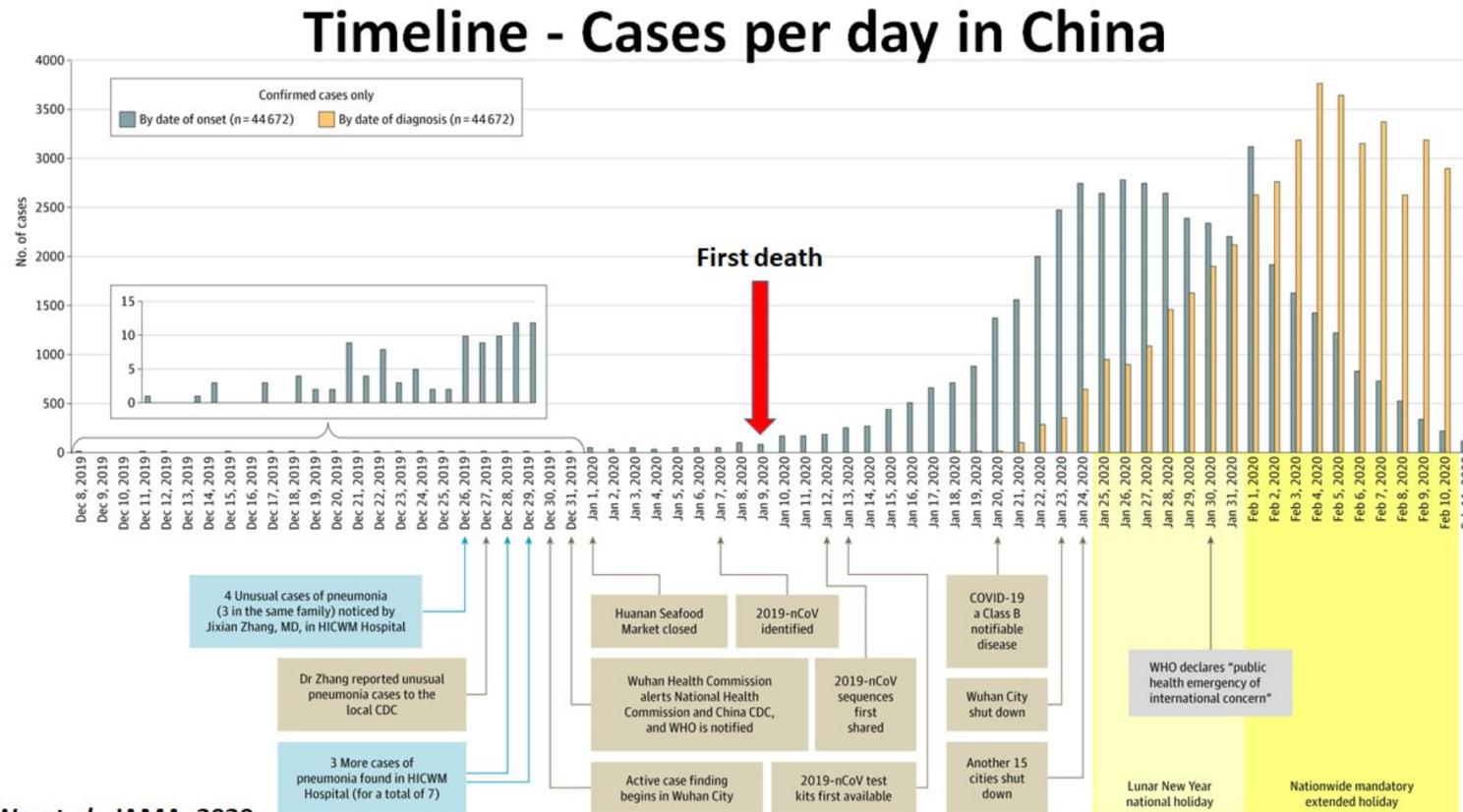
- Mortality for the Youngs very low...
- It's the flu for them—for you...
- And an extra doubling—or is it 5%?—mortality for the asthmatic
- And an extra doubling—or is it 5%?—mortality for the overweight



What We Think Happened in Wuhan

China beat it quickly & relatively easily!

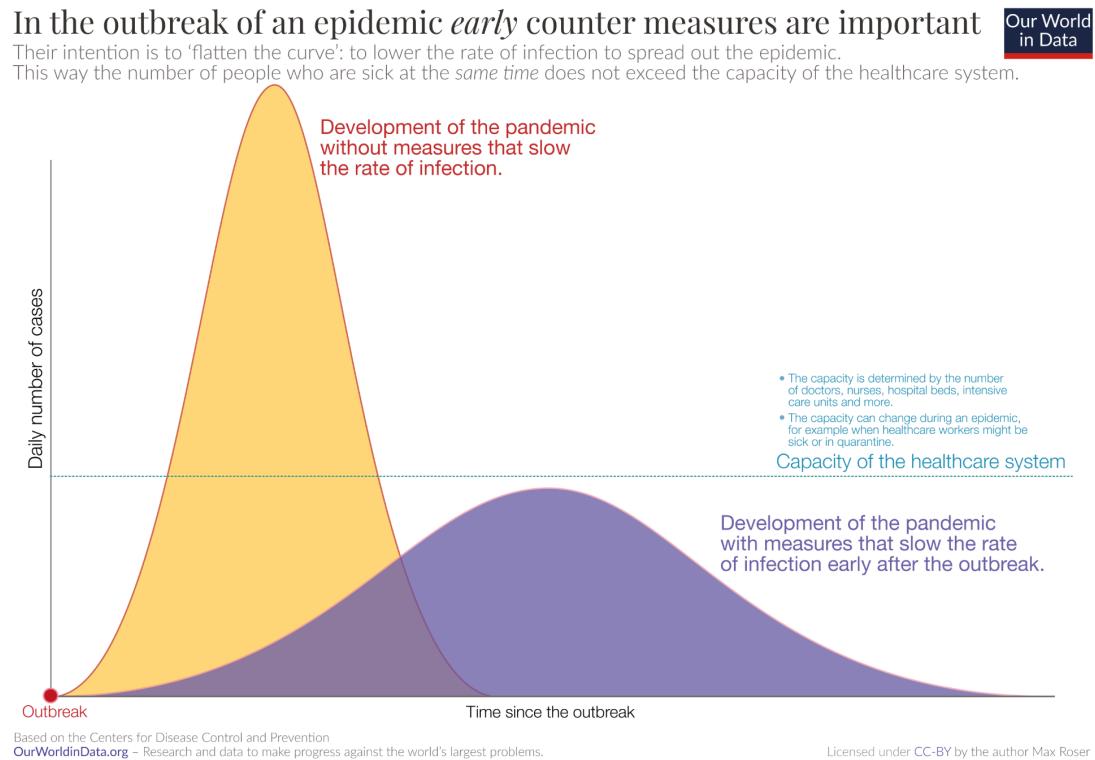
- We think
- Shut down Wuhan when 200 cases per day
- That seems to have been a good decision



The Goal

When Is It Appropriate to Move on This?

- Immediate social distancing...
- Self-isolate if you have a cough and a fever...
- Hope that warmer temperatures will do to this what they did to SARS...
- Otherwise, when do you want to start spreading out transmission. It seems that early is as good as later, so do it early...
 - I have no good intuition on why you want to move early
 - Plus your moving early will be wasted if you get reinfected
 - Plus the sparks you throw off making others' lives more difficult



References

- **Financial Times** (2020): Coronavirus Tracked: The Latest Figures as the Pandemic Spreads <<https://www.ft.com/coronavirus-latest>>
- **Nick Rowe** (2020): *Relative Supply Shocks, Unobtainium, Walras' Law, and the Coronavirus* <https://worthwhile.typepad.com/worthwhile_canadian_initi/2020/03/relative-supply-shocks-unobtainium-walras-law-and-the-coronavirus.html>
- **Jim Stock** (2020): *Coronavirus Data Gaps and the Policy Response* <<https://drive.google.com/file/d/12MV466ZZy5xHir4xdPhoTrL1oO8CbZU-/view>>

MOAR Coronavirus!

What I am watching:

- **Max Roser & Hannah Ritchie:** *Coronavirus Disease (COVID-19)* <<https://ourworldindata.org/coronavirus>>...
- **Worldometer:** *Coronavirus Update (Live)* <<https://www.worldometers.info/coronavirus/>>: '125,599 Cases and 4,605 Deaths from COVID-19 Virus Outbreak...'
- *FT Coronavirus Tracker* <<https://www.ft.com/content/a26fbf7e-48f8-11ea-aeb3-955839e06441>>
- Josh Marshall's COVID Twitter List <<https://twitter.com/i/lists/1233998285779632128>>
- NEJM Group: Updates on the Covid-19 Pandemic <http://m.n.nejm.org/nl/jsp/m.jsp?c=%40kxNtXckRDOq8oG0jJvAXsIzN4mPECIPhtxoTSdTU9k%3D&cid=DM89089NEJM_COVID-19_Newsletter&bid=173498255>: 'From the New England Journal of Medicine, NEJM Journal Watch, NEJM Catalyst, and other trusted sources...'

Catch Our Breath...

- Ask a couple of questions?
 - Make a couple of comments?
 - Any more readings to recommend?
-
- <<https://www.icloud.com/keynote/0YKEi7HeOrVGvKYtt9FEqH7nA>>
 - <<https://www.bradford-delong.com/2020/04/coronavirus.html>>
 - github:<<https://github.com/braddelong/public-files/blob/master/coronavirus.pptx>>
 - <https://github.com/braddelong/public-files/blob/master/coronavirus.pdf>
 - html File: <<https://www.bradford-delong.com/2020/04/coronavirus.html>>
 - Edit This File: <<https://www.typepad.com/site/blogs/6a00e551f08003883400e551f080068834/post/6a00e551f080038834025d9b3bd66a200c/edit>>
 - <<https://delong.typepad.com/files/2020-04-01-coronavirus.pdf>>



Coronavirus! (March 16)

With 31 deaths in the U.S. as of March 11, a 1% death rate, and up to 4 weeks between infection and death, that means that as of Feb 12 there were 3100 coronavirus cases in the United States.

With 87 deaths in the U.S. as of Mar 16, a 1% death rate, and up to 4 weeks between infection and death, that means that as of Feb 17 there were 8700 coronavirus cases in the United States

If it is doubling every seven days, then now about 150,000 people have and in the next week about 150,000 more people in the U.S. will catch coronavirus—which means 1/2200, currently 3500 of the 7.6 million inhabitants of San Francisco Bay. Touch a hard surface that any of those 3500 has touched in the last 48 hours, and the virus has a chance to jump to you...

These numbers could be five times too big. These numbers are probably not five times too small unless the thing is a lot less deadly, and there are a lot of asymptomatic cases...

- What is wrong with this analysis?

MOAR Coronavirus!

As of March 21: Things are not moving in the right direction:

- What is the R_0 ?
- How can the R_0 be changed?
- How will the R_0 change?
- What is the asymptote share of the population?
- What is the mortality rate?

Country, Other	Total Cases	New Cases	Total Deaths	New Deaths	Total Recovered	Active Cases	Serious, Critical	Tot Cases/1M pop
China	80,880	+36	3,213	+14	67,819	9,848	3,226	56.2
Italy	27,980	+3,233	2,158	+349	2,749	23,073	1,851	462.8
Iran	14,991	+1,053	853	+129	4,590	9,548		178.5
Spain	9,428	+1,440	335	+41	530	8,563	272	201.6
S. Korea	8,236	+74	75		1,137	7,024	59	160.6
Germany	7,241	+1,428	15	+2	65	7,161	2	86.4
France	5,423		127		12	5,284	400	83.1
USA	4,186	+506	73	+5	73	4,040	12	12.6
Switzerland	2,353	+136	19	+5	4	2,330		271.9
UK	1,543	+152	55	+20	52	1,436	20	22.7
Netherlands	1,413	+278	24	+4	2	1,387	45	82.5
Norway	1,323	+67	3		1	1,319	27	244.0

Coronavirus Cases:

179,836

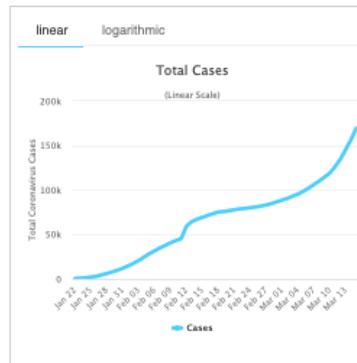
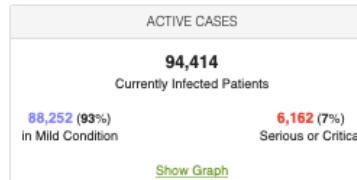
[view by country](#)

Deaths:

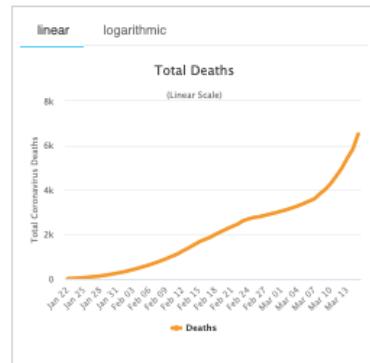
7,098

Recovered:

78,324



[More Case Statistics](#)



[More Death Statistics](#)

MOAR Coronavirus!

As of March 10: Things are not moving in the right direction:

- What is the R_0 ?
- How can the R_0 be changed?
- How will the R_0 change?
- What is the asymptote share of the population?
- What is the mortality rate?

Coronavirus Cases:

125,599

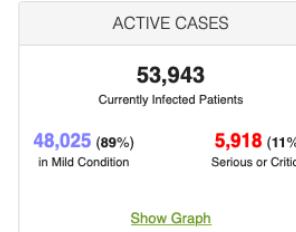
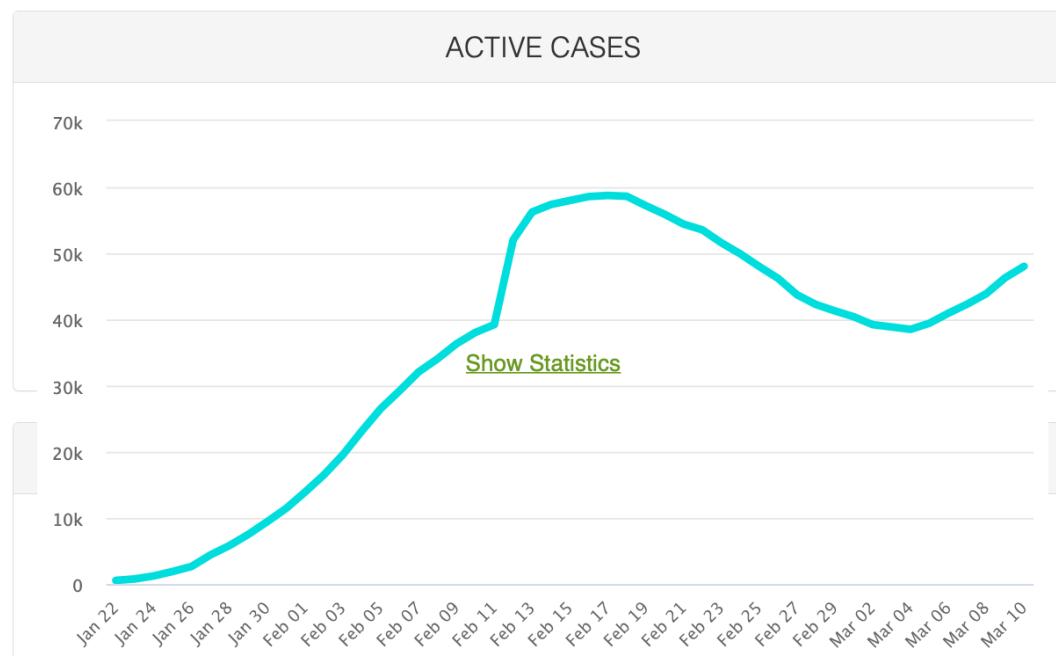
[view by country](#)

Deaths:

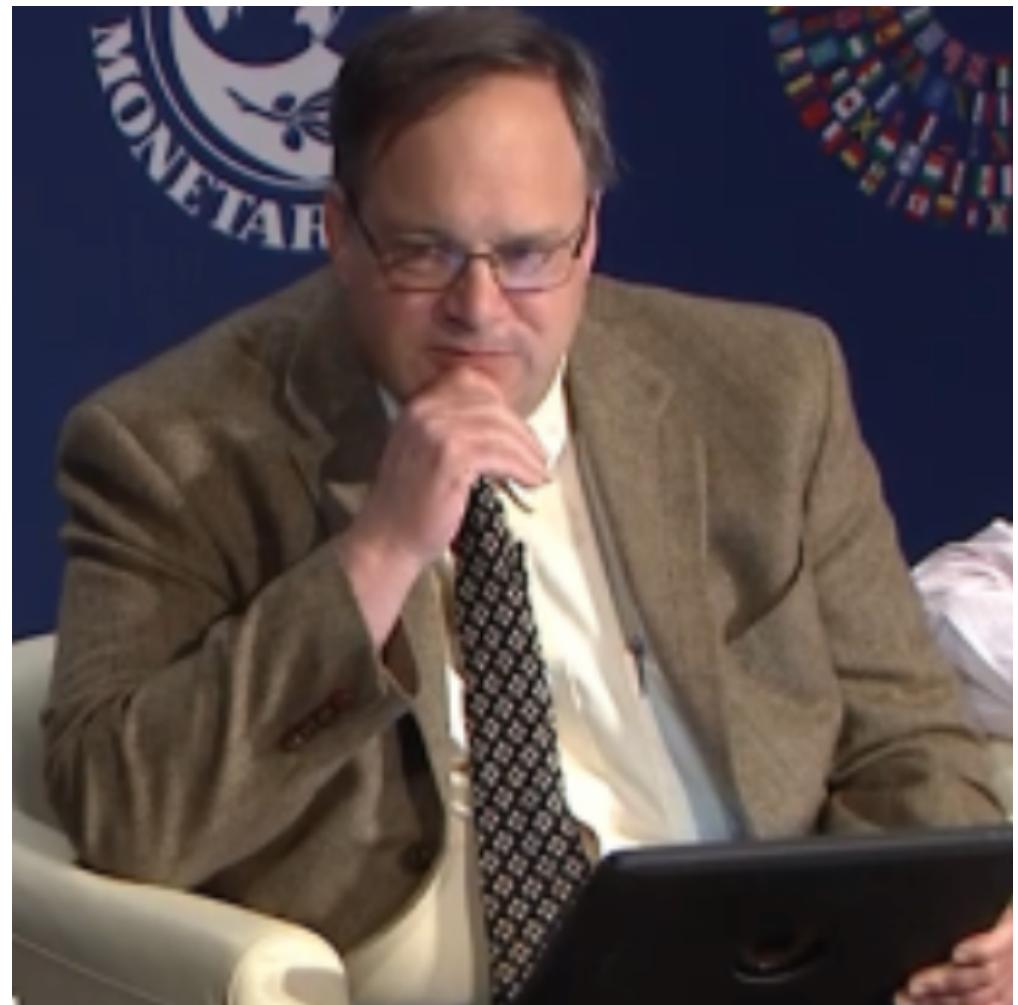
4,605

Recovered:

67,051



Notes



Permanent Agrarian Age World

What if there had been no Commercial Revolution?

- What would we have to eliminate from our world?
 - The New World & the Columbian Exchange
 - Merchant republics & constitutional monarchies
 - Printing as transformative for intellectual life?
- Is this plausible?
- Rate of ideas growth settles at $0.035\%/\text{yr} = 0.7\%/\text{generation}$
 - Doubling time of 2000 years
- World today of 1/10 population, \$2.50/day
 - Population growing at glacial pace

Permanent Agrarian Scenarios

Date	Human Population (millions)	Income per Capita (per year)	World Product (billions)	Rate of Population and Labor Force Growth n	Rate of Efficiency-of-Labor Growth g	Rate of Ideas-Stock Growth h
-48000	1	\$1,200	\$1			
-8000	3	\$1,200	\$4	0.003%	0.000%	0.0014%
-3000	15	\$900	\$14	0.032%	-0.006%	0.0103%
-1000	50	\$900	\$45	0.060%	0.000%	0.0301%
0	170	\$900	\$153	0.122%	0.000%	0.0612%
800	300	\$900	\$270	0.071%	0.000%	0.0355%
1500	500	\$900	\$450	0.073%	0.000%	0.0365%
1770	609	\$900	\$548	0.073%	0.000%	0.0364%
1870	655	\$900	\$589	0.073%	0.000%	0.0364%
2020	730	\$900	\$657	0.073%	0.000%	0.0364%
2100	774	\$900	\$696	0.073%	0.000%	0.0364%
2200	832	\$900	\$749	0.073%	0.000%	0.0364%

Gunpowder Empire World

What if things had stuck at the Commercial Revolution?

- What would we have to eliminate from our world?
 - Coal or the British Empire
 - Science, tinkering, and nature manipulation?
- Is this plausible?
- Global rate of ideas growth of 0.15%/yr = 4%/generation, broadly shared
 - Doubling time of 500 years
- World today of 1/5 our population, \$3/day

Gunpowder Empire Scenarios

Date	Human Population (millions)	Income per Capita (per year)	World Product (billions)	Rate of Population and Labor Force Growth n	Rate of Efficiency-of-Labor Growth g	Rate of Ideas-Stock Growth h
-48000	1	\$1,200	\$1			
-8000	3	\$1,200	\$4	0.003%	0.000%	0.0014%
-3000	15	\$900	\$14	0.032%	-0.006%	0.0103%
-1000	50	\$900	\$45	0.060%	0.000%	0.0301%
0	170	\$900	\$153	0.122%	0.000%	0.0612%
800	300	\$900	\$270	0.071%	0.000%	0.0355%
1500	500	\$900	\$450	0.073%	0.000%	0.0365%
1770	750	\$1,100	\$825	0.150%	0.074%	0.1494%
1870	895	\$1,169	\$1,047	0.177%	0.061%	0.1494%
2020	1402	\$1,169	\$1,639	0.299%	0.000%	0.1494%
2100	1780	\$1,169	\$2,081	0.299%	0.000%	0.1494%
2200	2400	\$1,169	\$2,806	0.299%	0.000%	0.1494%

Steampunk World

What if there had been no Industrial Revolution?

- What would we have to eliminate from our world?
 - Post-1870 speedup of STEM labor force growth
 - Industrial research lab to rationalize & routinize & modern corporation to deploy ideas
 - Globalization?
- Is this plausible?
 - Stepping-on-toes & low-hanging-fruit
 - Arguments that it was inevitable lead to expectations of further growth accelerations—which we have not had
- World settles at ideas growth of 0.44%/yr—12%/
generation
 - doubling time of 150 years
- World today of 2.7 billion, \$5/day
- World reaches today's population in 2200

Steampunk Scenarios

Date	Human Population (millions)	Income per Capita (per year)	World Product (billions)	Rate of Population and Labor Force Growth n	Rate of Efficiency-of-Labor Growth g	Rate of Ideas-Stock Growth h
-48000	1	\$1,200	\$1			
-8000	3	\$1,200	\$4	0.003%	0.000%	0.0014%
-3000	15	\$900	\$14	0.032%	-0.006%	0.0103%
-1000	50	\$900	\$45	0.060%	0.000%	0.0301%
0	170	\$900	\$153	0.122%	0.000%	0.0612%
800	300	\$900	\$270	0.071%	0.000%	0.0355%
1500	500	\$900	\$450	0.073%	0.000%	0.0365%
1770	750	\$1,100	\$825	0.150%	0.074%	0.1494%
1870	1300	\$1,300	\$1,690	0.550%	0.167%	0.4421%
2020	2878	\$1,696	\$4,880	0.530%	0.177%	0.4421%
2100	5838	\$1,696	\$9,900	0.884%	0.000%	0.4421%
2200	7871	\$1,696	\$13,348	0.884%	0.000%	0.4421%