
Coronavirus update: COVID-19 and the markets

March 20, 2020

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Where can I find all these charts and what they mean

Private Bank

www.jpmorgan.com/coronavirus-research

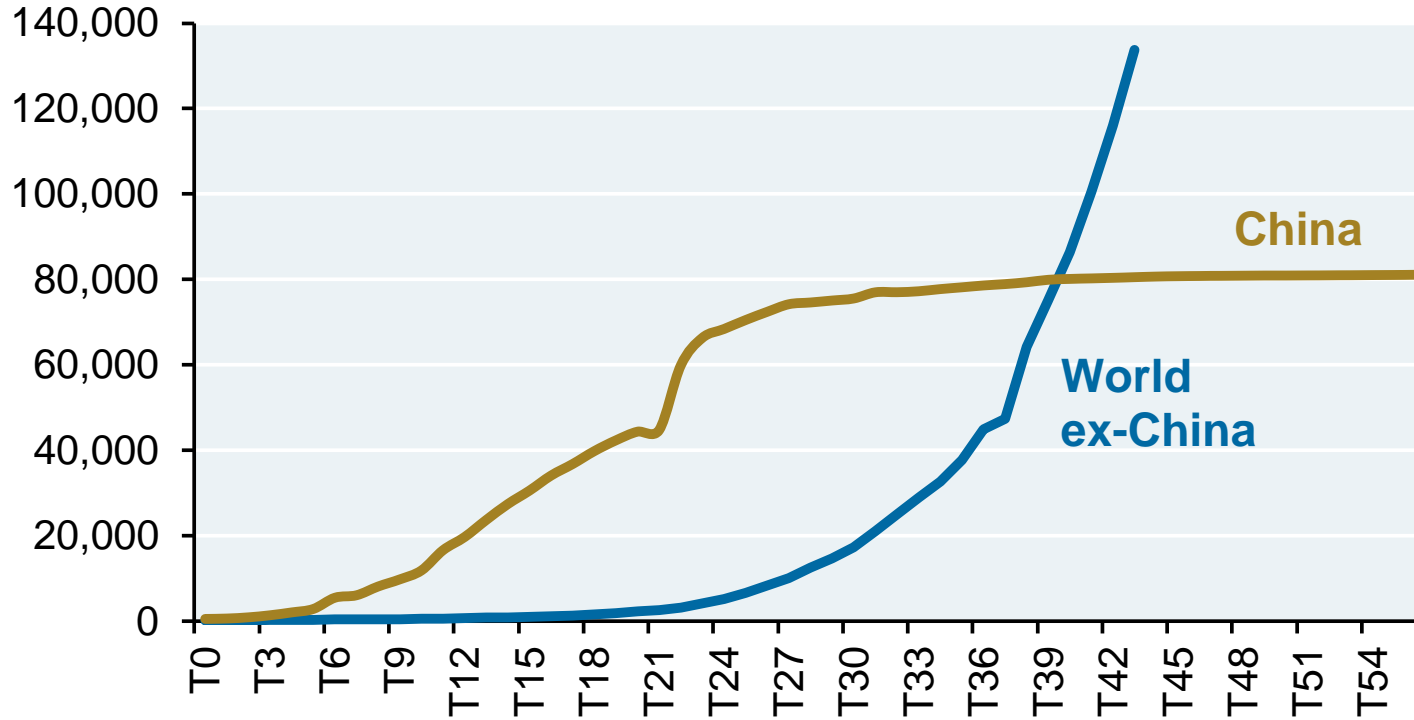
Asset Management

www.jpmorgan.com/coronavirusupdates

Infection counts

Coronavirus T days after respective region's outbreak

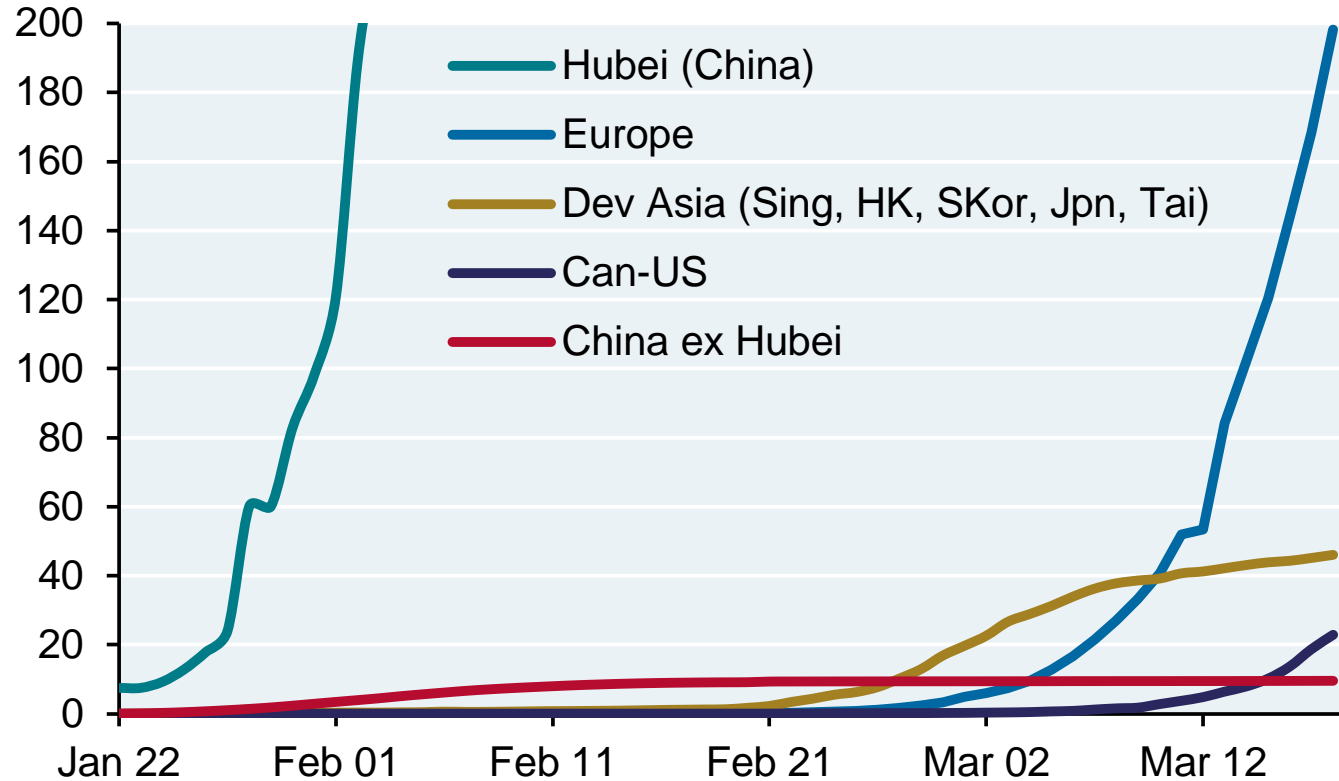
Cumulative number of cases



Source: JHU. March 18, 2020. T0: China = Jan 22, Outside China = Feb 4.

East vs West: cultural differences; SARS impact on behaviors; ability of federal and local governments to monitor and enforce population movement restrictions; testing capabilities, etc

Infections per 1 million people by region



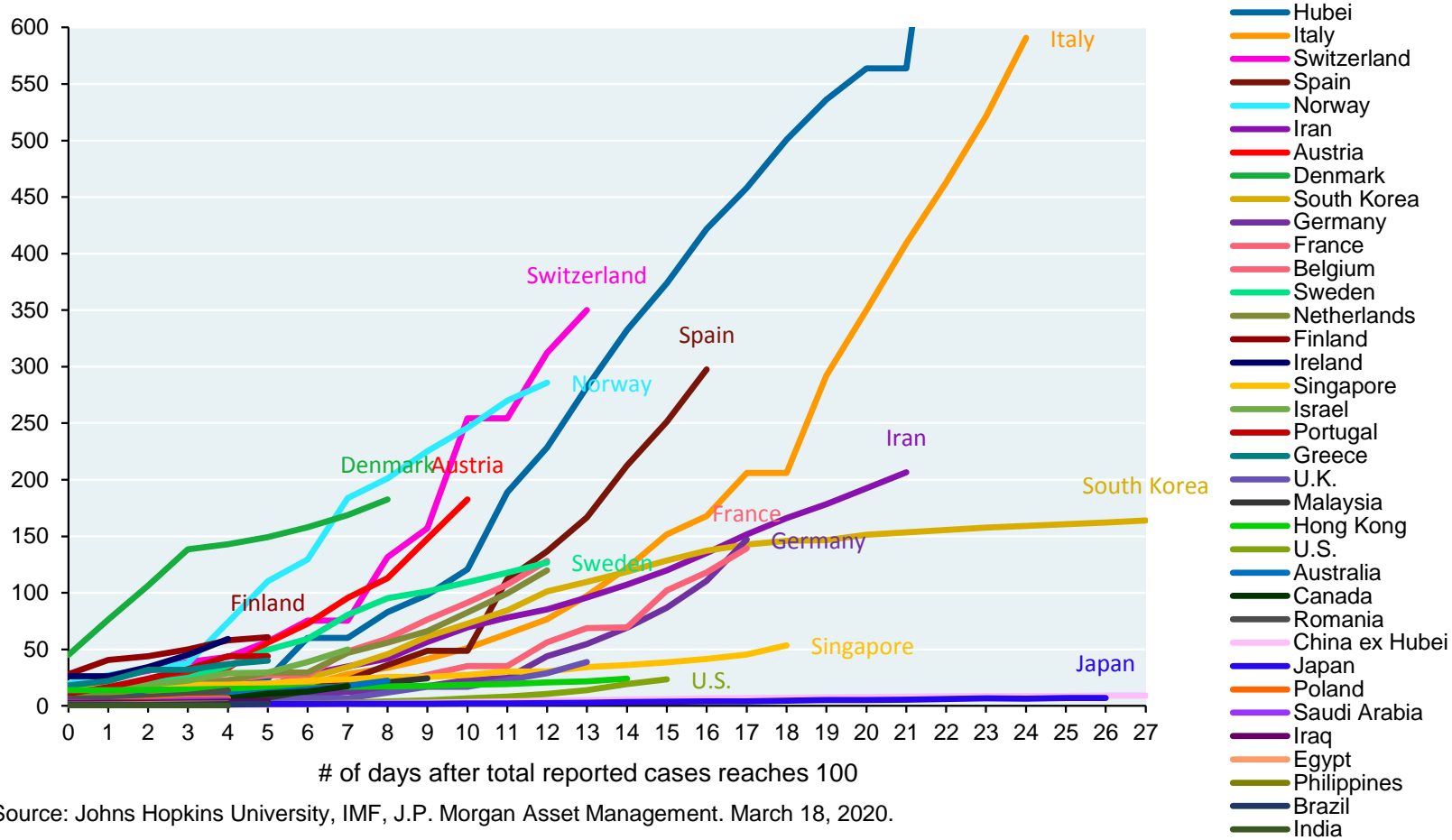
Source: Johns Hopkins University, IMF, JPMAM. March 18, 2020.

The example of Taiwan

- QR code scanning and online reporting of each person's travel history
- Health symptoms were used to classify traveler infectious risks based on flight origin and travel history in the past 14 days
- People with low risk were sent a health declaration border pass via SMS to their phones for faster immigration clearance
- Those with higher risk were quarantined at home and tracked through their mobile phone to ensure that they remained there during the incubation period
- Taiwan also proactively seeks out patients with severe respiratory symptoms (based on information from a national health database) to see who had tested negative for influenza so that they could be retested for COVID-19

Infection rates

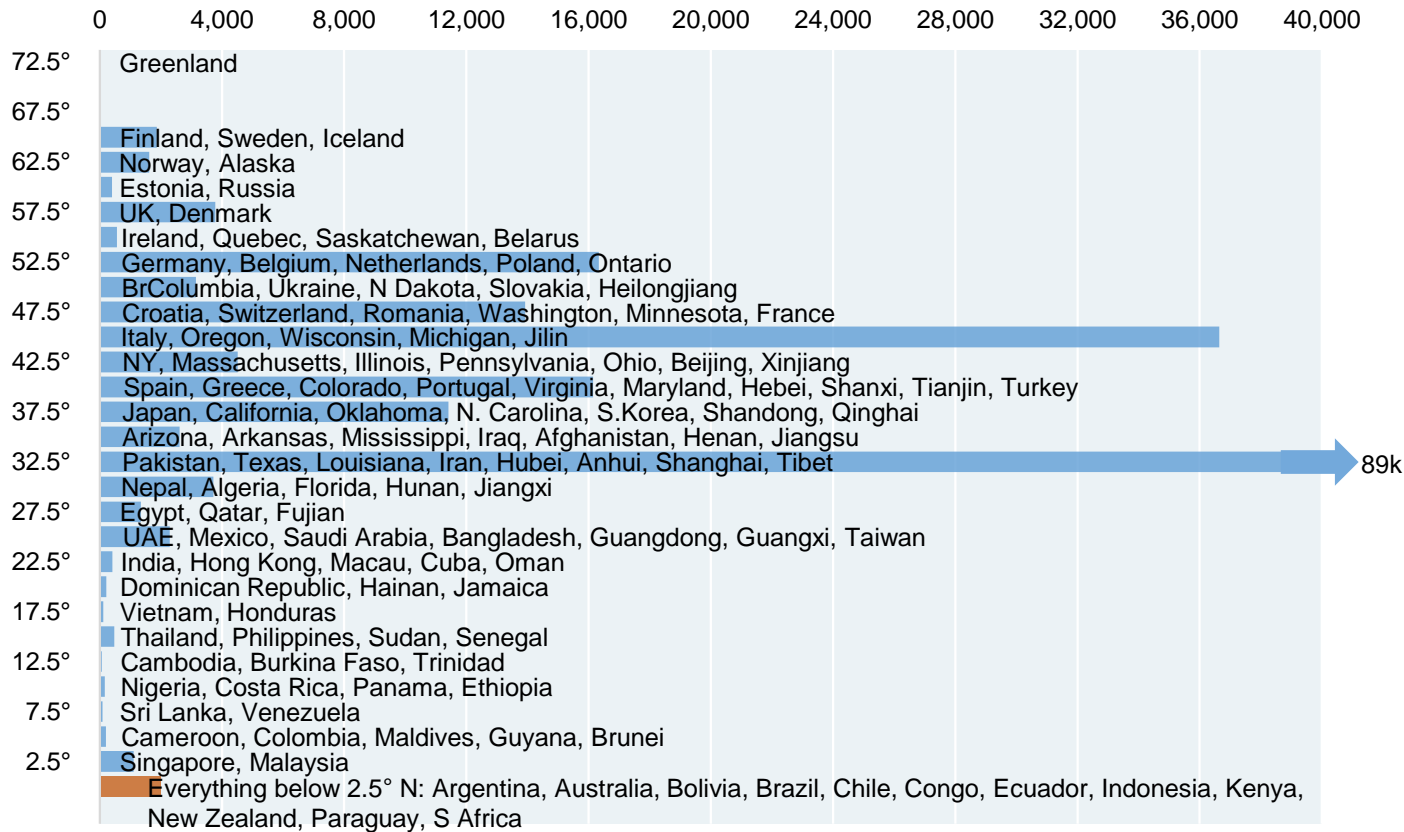
Reported infections per 1 million people for countries with over 100 reported cases for at least the last 5 days



Source: Johns Hopkins University, IMF, J.P. Morgan Asset Management. March 18, 2020.

Reported infections as a function of latitude: for now, the one third of the world's population below 22.5°N has not experienced meaningfully high levels of infection

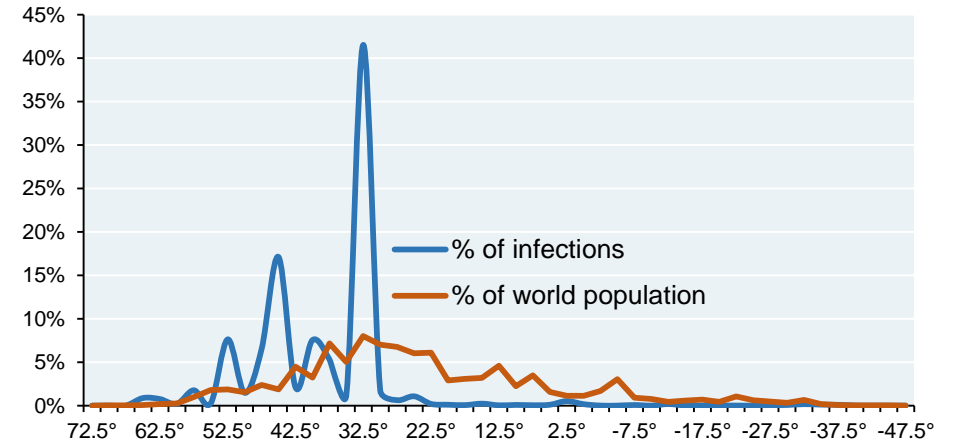
Global reported infections by latitude



Source: Johns Hopkins, JPMAM. March 18, 2020

95% of all infections in a latitude band encompassing 55% of the world's population

Infections and world population as a function of latitude



Source: Johns Hopkins University, NASA, JPMAM. March 17, 2020.

Infections as a function of temperature and humidity: 90% still in the blue zone

Infections as a function of prevailing temperature and relative humidity

		Relative humidity (percent)						
		Below 5	5 to 20	20 to 35	35 to 50	50 to 65	65 to 80	80 to 95
Temperature (Celsius)	Below -10	-	-	1	-	-	232	-
	-10 to -5	-	125	246	1,123	470	234	-
	-5 to 0	-	2,601	8,466	1,142	1,280	3,302	899
	0 to 5	58	1,749	2,858	444	1,212	4,024	25
	5 to 10	-	2,705	53,944	19,232	4,950	448	173
	10 to 15	-	-	9,550	81,748	2,102	164	-
	15 to 20	-	279	452	1,817	106	536	65
	20 to 25	269	196	202	991	1,016	1,171	-
	25 to 30	76	-	11	30	-	-	-
	30 to 35	61	11	6	-	-	-	-
	35 to 40	-	-	-	-	-	-	-

Source: WHO, Johns Hopkins, OpenWeatherMapAPI, JPMAM, March 18, 2020

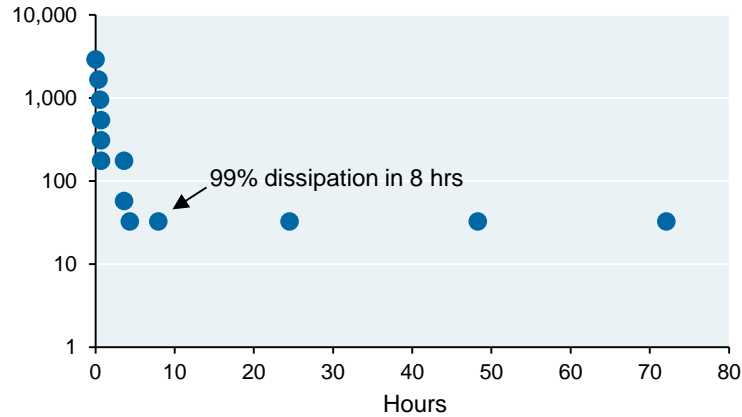
What we have learned about the virus

- Up to 85% of infections occur in family clusters
- Most of the remainder occurred due to contact with hard surfaces in the immediate environment of those with infection
- Limited instances of hospital-borne infection
- Although asymptomatic patients were reported for SARS, no known transmission occurred from these patients
 - Basic reproductive number (a measure of transmissibility): similar to SARS
 - Incubation time (how long it takes to show symptoms): similar to SARS
 - Serial interval (how long it takes to become infectious to others): different, and that's the root of the problem
 - Average symptoms show up on Day 5, contagiousness can begin on Day 4

COVID-19 (SARS-CoV-2) and surfaces: rapid time-decay of viral load

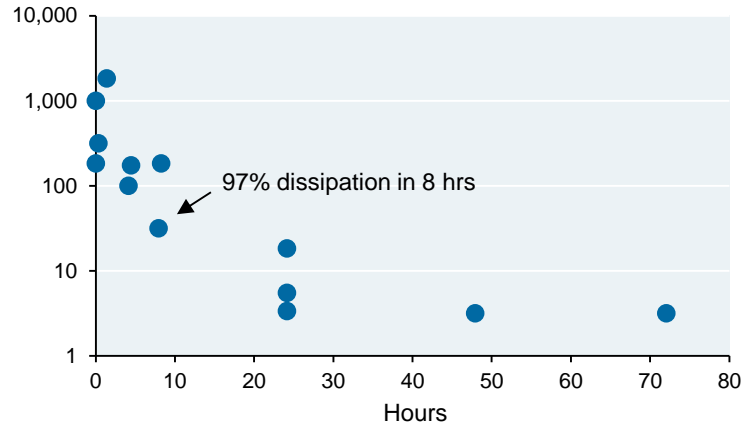
Decay of SARS-CoV-2 on Copper

Viral load measure, TCID₅₀ per ml of medium



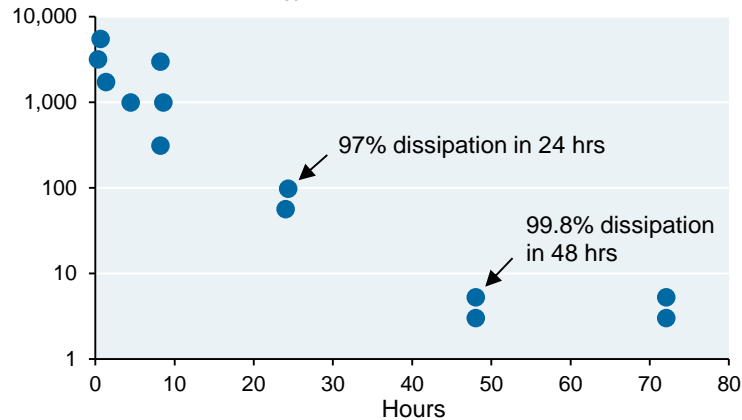
Decay of SARS-CoV-2 on Cardboard

Viral load measure, TCID₅₀ per ml of medium



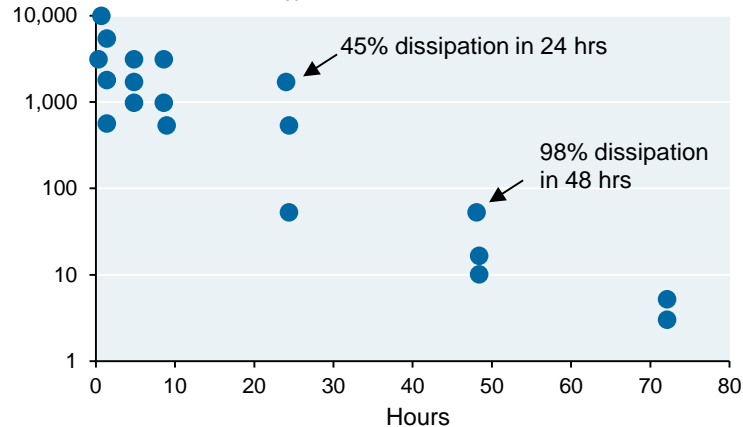
Decay of SARS-CoV-2 on Stainless Steel

Viral load measure, TCID₅₀ per ml of medium



Decay of SARS-CoV-2 on Plastic

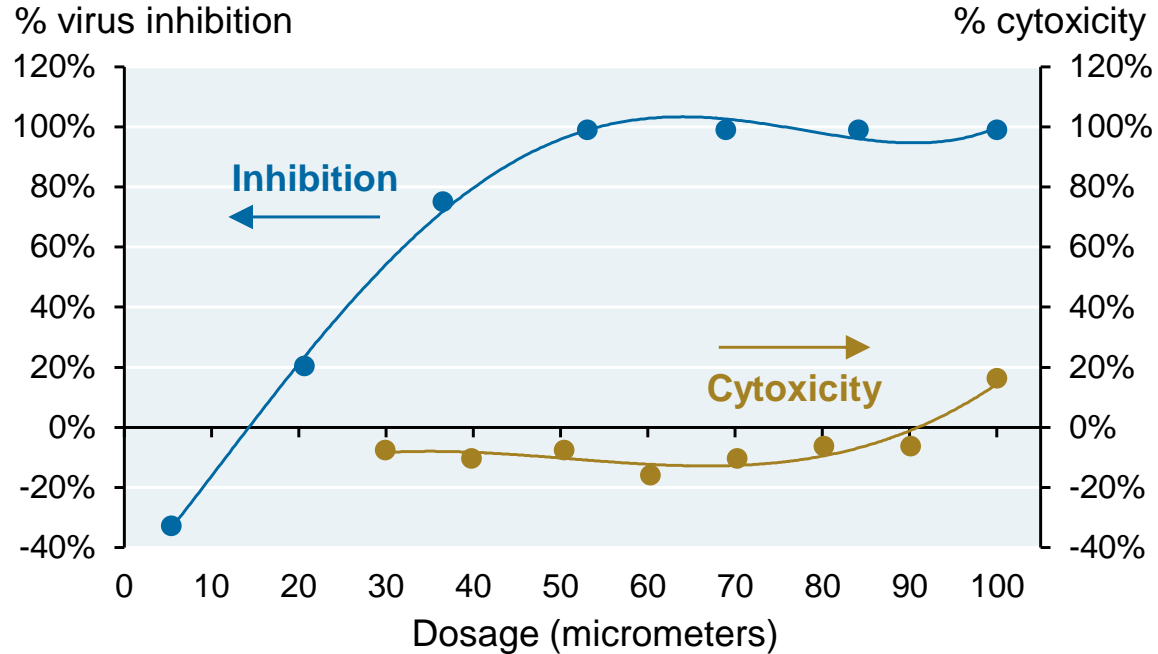
Viral load measure, TCID₅₀ per ml of medium



Source: van Doremalen et al, "Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1", National Institute of Allergy and Infectious Diseases. 2020.

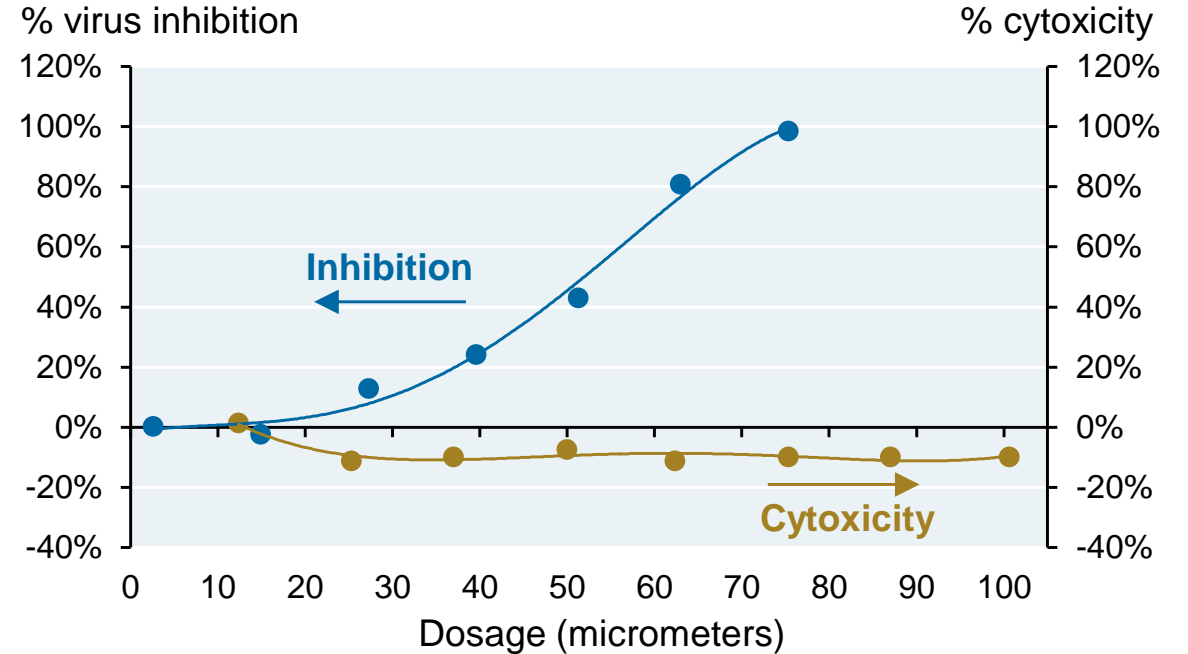
Some promising news in development of anti-viral medications

Remdesivir tests against 2019-nCoV in cell cultures



Source: Wuhan Institute of Virology. February 4, 2020.

Chloroquine tests against 2019-nCoV in cell cultures

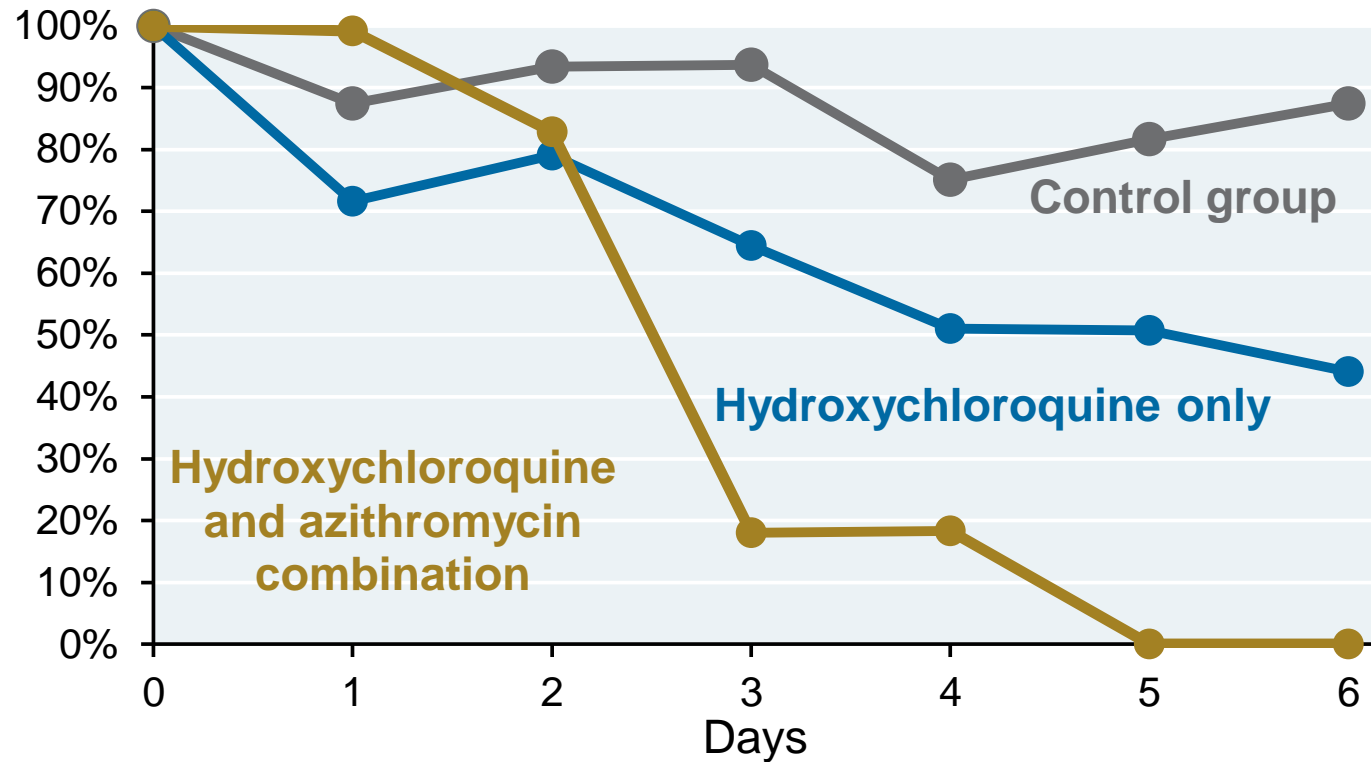


Source: Wuhan Institute of Virology. February 4, 2020.

Some promising news in development of anti-viral medications

Treatment results of patients with COVID-19

% of patients that test positive for infection



Source: Gautret et al, IHU-Méditerranée Infection. March 2020.

Drug development underway: vaccines, direct viral inhibitors and immunomodulators

Drug	Companies	Status	Type
Favipiravir	Fujifilm; Medivector; Zhejiang Hisun Pharmaceutical	Launched	Antiviral
Actemra	Genentech/Roche	Launched	Immuno-modulator
Rintatolimod	Aim Immunotech; GP Pharm SA; Goethe University	Launched	Immuno-modulator
ASC-09 + ritonavir	Asclepis Pharma	Phase III	Anti-retroviral
Remdesivir	Gilead	Phase III	Antiviral
Kevzara	Regeneron/Sanofi	Phase III/II	Immuno-modulator
BDB-1	Beijing Defengrei Biotechnology	Phase II	Antibody
Brilacidin	Innovation Pharmaceuticals	Phase II	Antibody

Drug	Companies	Status	Type
INO-4800	Beijing Advaccine Biotech; GeneOne Life Science; Inovio	Preclinical	Vaccine
CYNK-001	Celularity; Sorrento Therapeutics	Preclinical	Cell Therapy
SARS-CoV-2 vaccine	Chongqing Zhifei Biological; Institute of Microbiology	Preclinical	Vaccine
Adjuvant/COVID-19 vaccine	Novavax	Preclinical	Vaccine
S-protein/ACE2	Sichuan Kelun Pharmaceutical	Preclinical	Prophylactic polypeptide
ChAdOx1 nCoV-19	Jenner Institute	Preclinical	Vaccine
Mesenchymal stem cells	Wuhan Hamilton Biotechnology	Preclinical	Cell Therapy

Drug	Companies	Status	Type
Dendritic cell vaccine	Beijing Dingcheng Taiyuan Biotechn; Betta Pharma	Discovery	Vaccine
Recombinant vaccine	Clover Biopharmaceuticals	Discovery	Vaccine
Live-attenuated vaccine	Codagenix; Serum Institute of India	Discovery	Vaccine
SARS-CoV-2 mRNA vaccine	Curevac AG	Discovery	Vaccine
Monoclonal antibodies/vaccine	Dyadic International; Israel Institute for Biological Res	Discovery	Antibody/Vaccine
SARS-CoV-2 vaccine	Fudan University; ID Pharma	Discovery	Vaccine
Z-VacciRNA	Guanhao Biotech; Zy Therapeutics	Discovery	Vaccine

Protein subunit vaccine	University of Queensland	Discovery	Vaccine
Monoclonal antibodies	Vir Biotechnology	Discovery	Antibody
Anti-SARS-CoV-2 program	Nanoviricides	Discovery	Nanoviricide

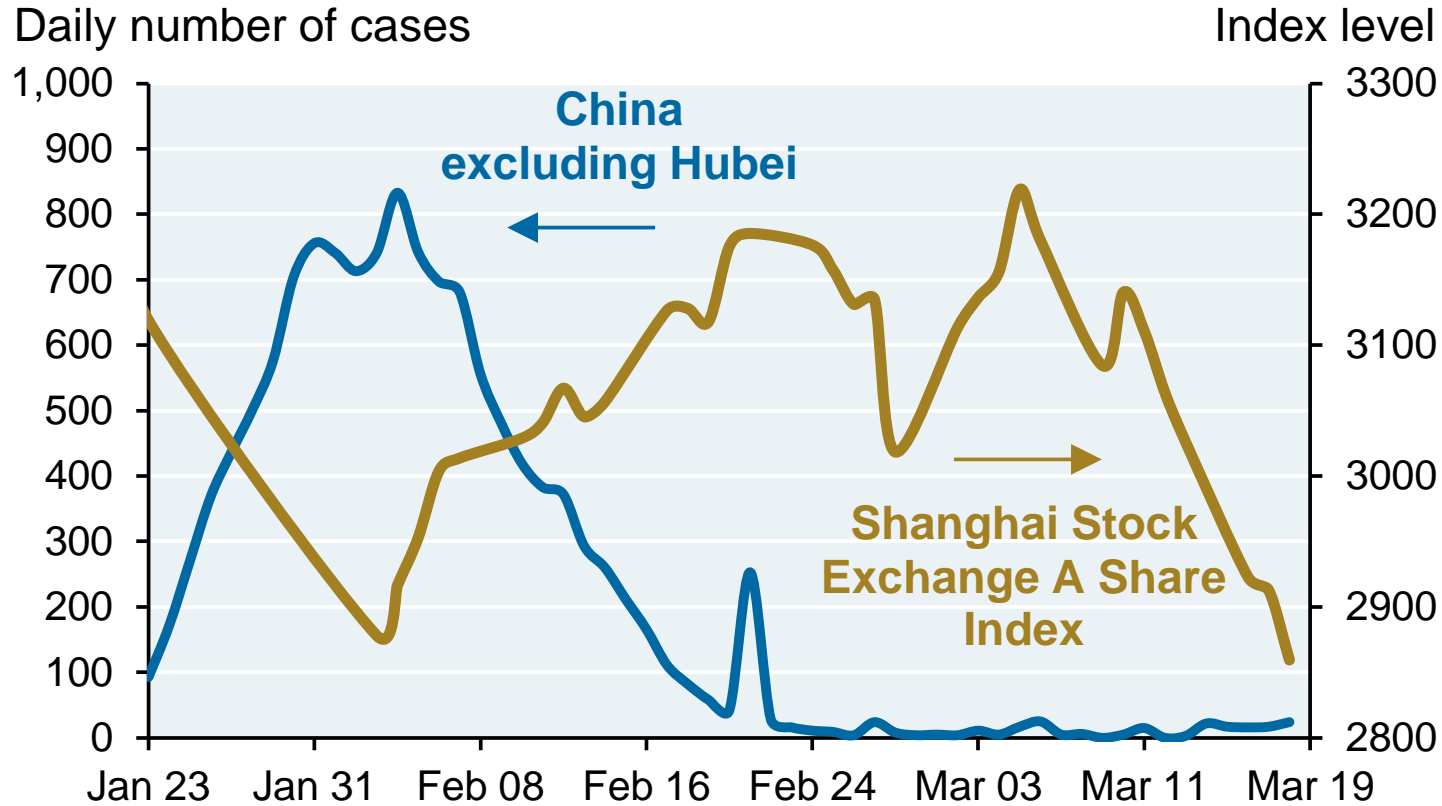
Antibodies	Regeneron Pharmaceuticals	Discovery	Antibody
Protein subunit vaccine	Sanofi Pasteur	Discovery	Vaccine
Coronavirus vaccine	Vaxart	Discovery	Vaccine

SARS-CoV-2 vaccine	Medigen' National Institutes of Health	Discovery	Vaccine
mRNA-1273	Moderna Therapeutics	Discovery	Vaccine
Antibodies	Immunoprecise Antibodies	Discovery	Antibody

Source: Cortellis, Bioworld, Johns Hopkins, JPMAM. As of March 5, 2020.

China equity markets and infections

Chinese daily infections versus Chinese equities

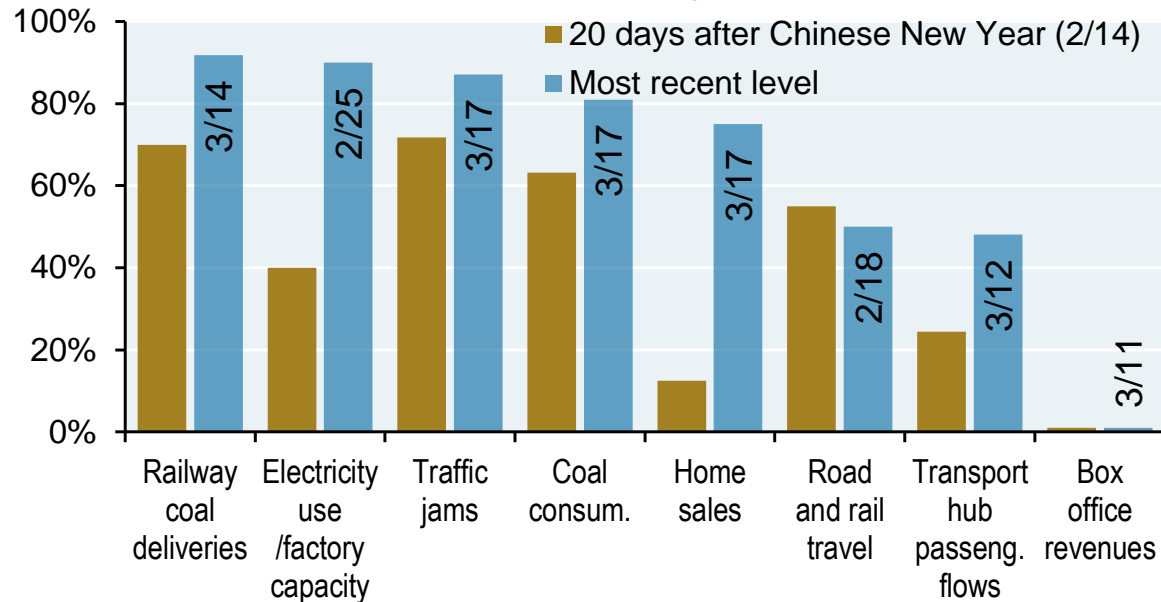


Source: Bloomberg, Johns Hopkins University. March 18, 2020.

A key litmus test for the world: what will happen to infection rates in China as lockdown provisions and quarantine provisions are relaxed? Risks of a “second wave” of infections

High frequency Chinese economic indicators

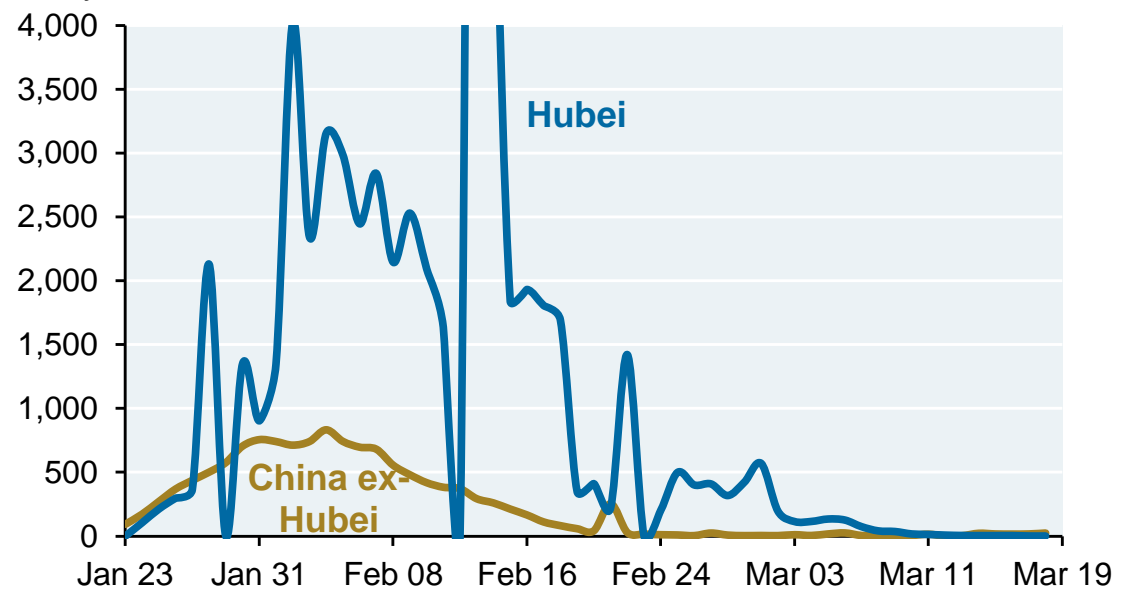
Indicated level as a % of historical average



Source: J.P. Morgan Emerging Markets Research, Goldman Sachs. Mar 18, '20.

Chinese daily infections: Hubei vs ex-Hubei

Daily number of cases



Source: Bloomberg, Johns Hopkins University. March 18, 2020.

One possible scenario for the US

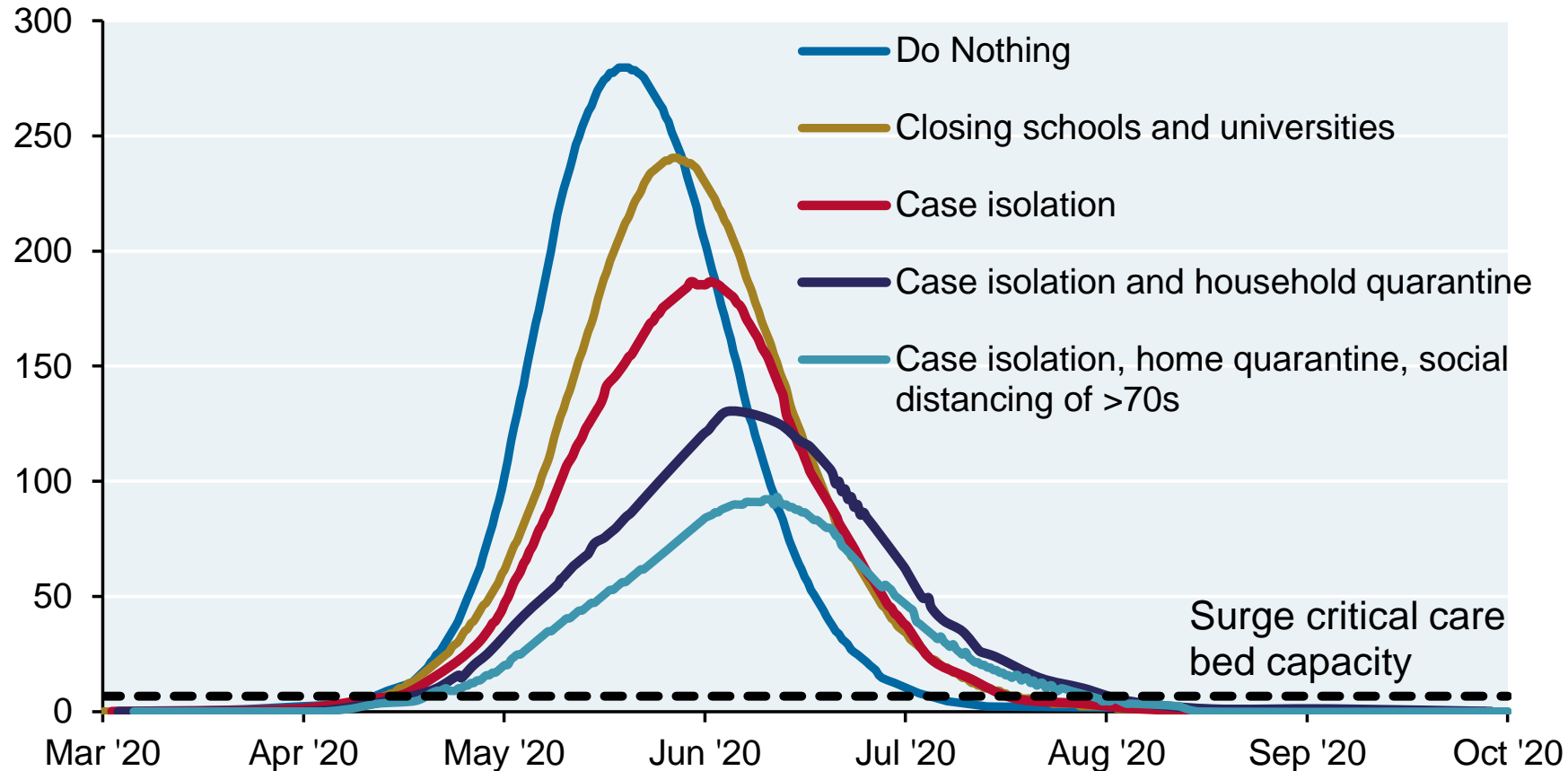
Best guess epidemiology outcomes for the US James Lawler, MD, MPH, FIDSA, University of Nebraska Region VII disaster health response ecosystem webinar

Reproductive number	2.5
Doubling time	7-10 days
Community attack rate	30-40%
Cases	96 million
Hospital admissions	4.8 million (5%)
Cases requiring ICU care	1.9 million (1-2%)
Cases requiring ventilatory support	1%
Deaths	480,000 (0.5%)

Source: Region VII Disaster Health Response Ecosystem. Feb 27, 2020.

Where “flattening the curve” comes from

Great Britain critical care beds occupied per 100,000 of population

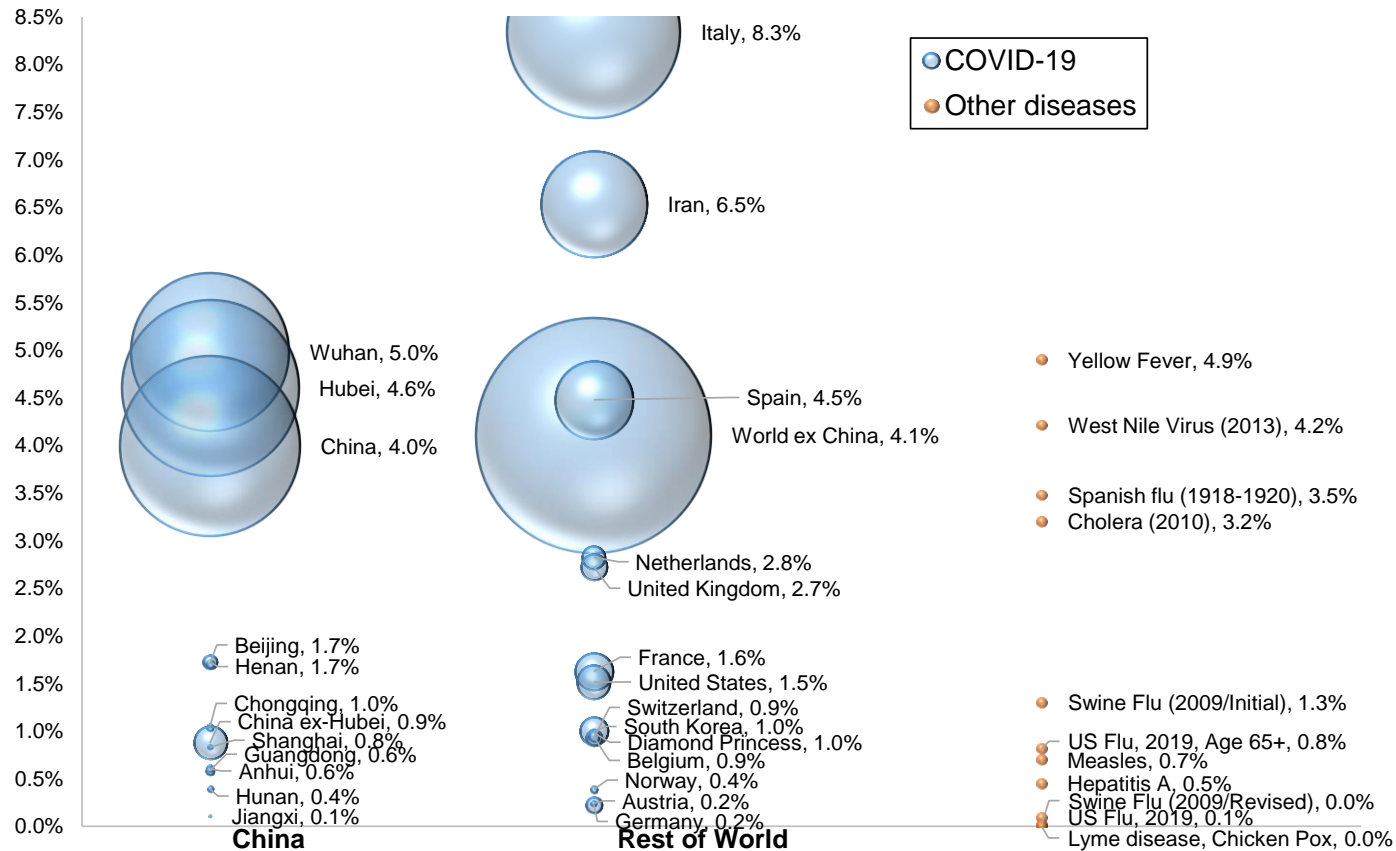


Source: "Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand", N Ferguson et al, Imperial College of London, March 2020.

Mortality as a % of reported infections

Mortality rates: COVID-19 vs other diseases, and the impact of Wuhan/Hubei

Mortality rate; bubble size indicates relative number of fatalities for COVID-19 only



Mortality rates shown for all countries with at least 1,000 infections to date. Sources: CDC, China National Health Commission, Center for Health Protection (HK), Global Health Data Exchange, Johns Hopkins University, Netherlands Institute for Health Services Research, Imperial College of London, Mayo Clinic, World Health Organization, JPMAM. March 18, 2020.

Pandemic measures:

- (a) population of a given geographical area
- (b) infected individuals, including both asymptomatic people and people that get sick
- (c) people that are infected, get sick and self-report
- (d) number of people that die

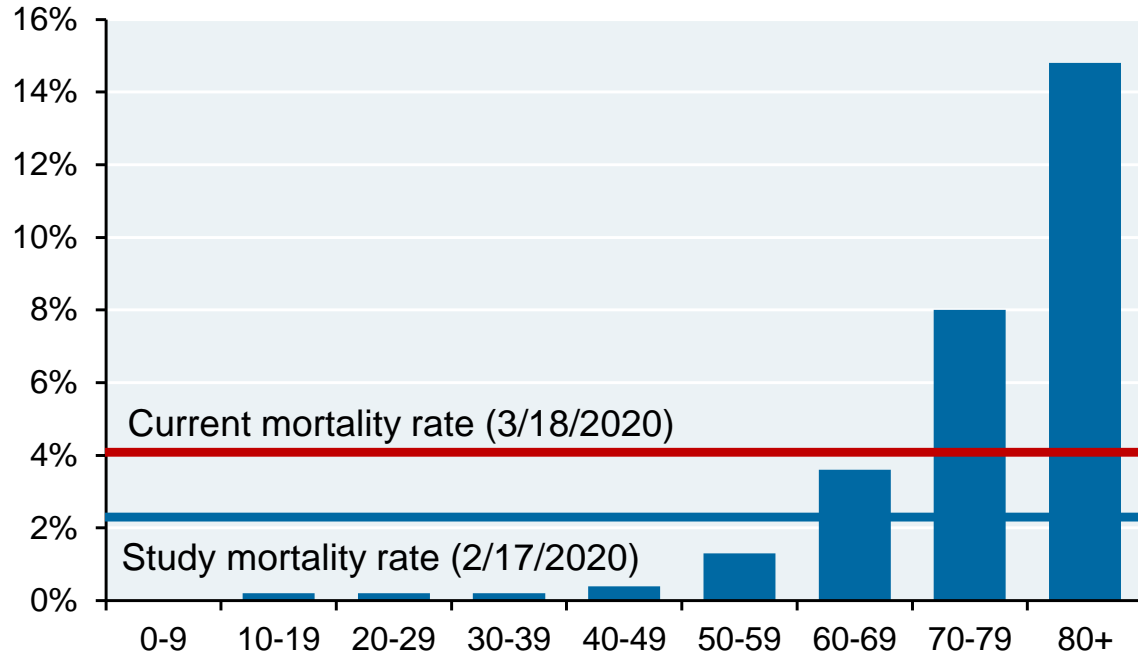
During the haze of a pandemic, best estimates that entities like the World Health Organization often derive are based on (a), (c) and (d), and even things like (d) are complicated by pandemics affecting older individuals with pre-existing conditions. They do not know (b) upfront, and sometimes it is never known, or only known with the passage of time. Swine Flu (H1N1/2009) example. Early mortality rate estimates in fall 2009: 1.0%-1.3%. Four years later: just 0.02%.

GIMBE Foundation: Italy infections likely ~100,000, which would reduce observed mortality rate to 2%

Diamond Princess cruise ship: ability to observe both symptomatic and asymptomatic individuals

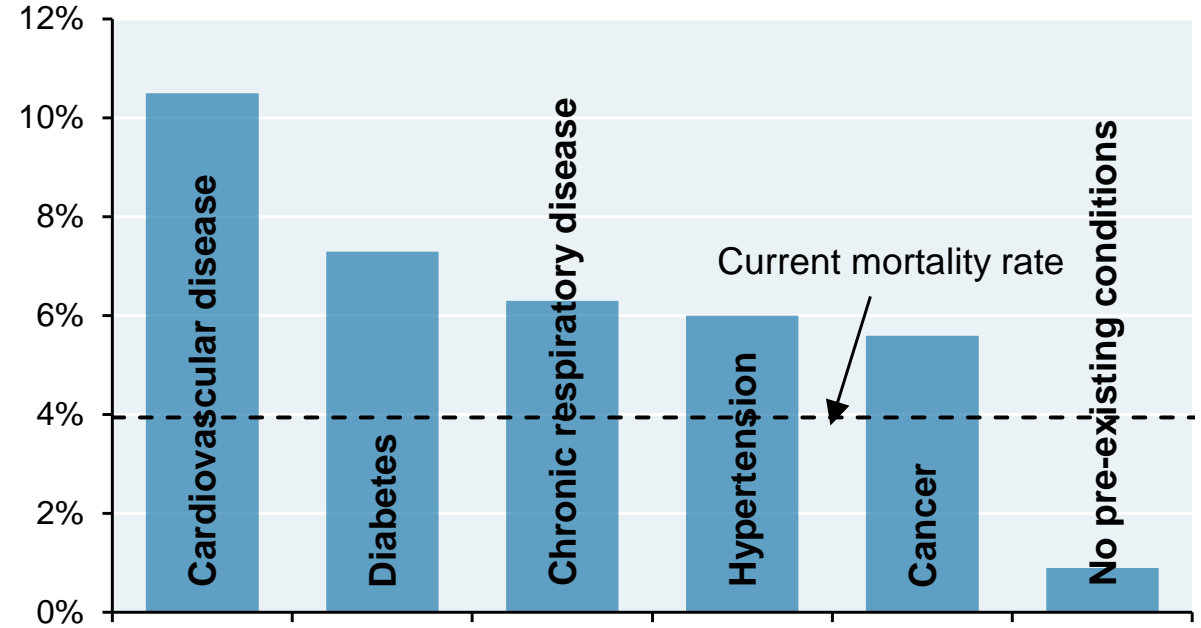
Infection and mortality rates

Coronavirus mortality rate by age



Source: Chinese CDC, WHO. February 2020.

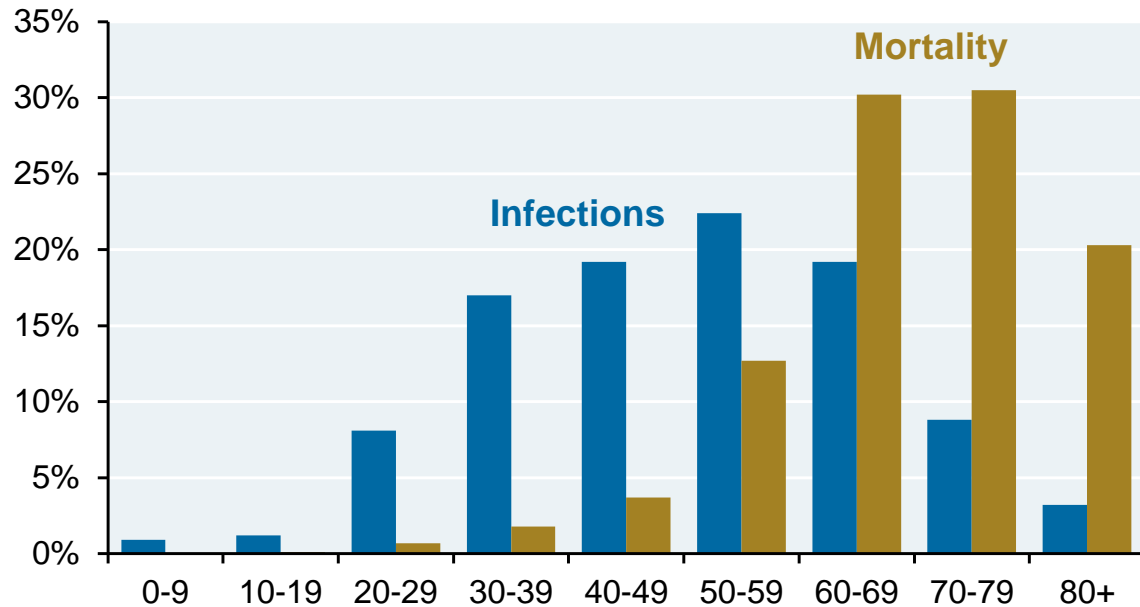
Coronavirus mortality rate based on pre-existing conditions



Source: Chinese Center for Disease Control and Prevention. February 2020.

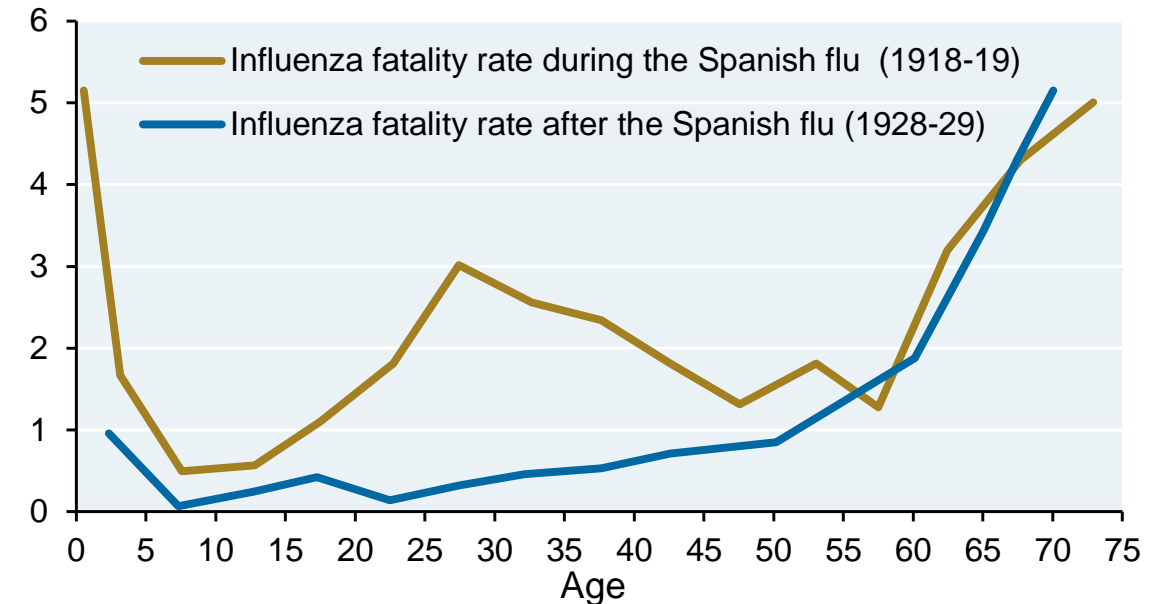
Infection and mortality rates

Distribution of COVID-19 mortality and infections by age
% of total infected or deceased population



Source: Chinese Center for Disease Control and Prevention. February 2020.

Case fatality rate during and after the Spanish flu
Fatalities per 100 infected persons

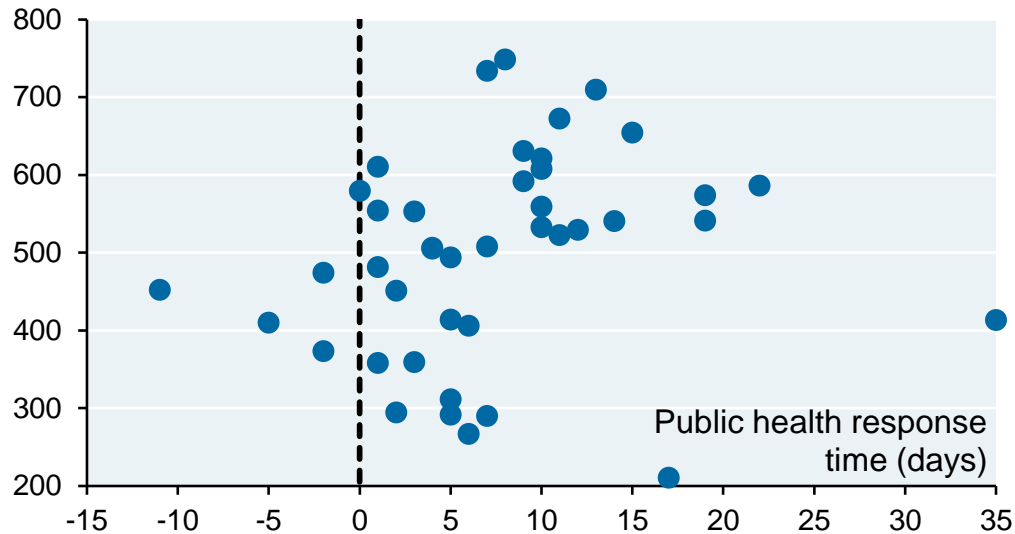


Source: Taubenberger and Morens. 2006.

In Italy, mortality distribution even more skewed to the elderly: 88% of deaths occurred in population 70+, compared to 50% in China

Lessons learned 100 years ago, ignored in China

Excess pneumonia & influenza mortality in 43 US cities, 1918-1919, Excess deaths per 100,000 population



Source: Markel et al, University of Michigan. 2007.

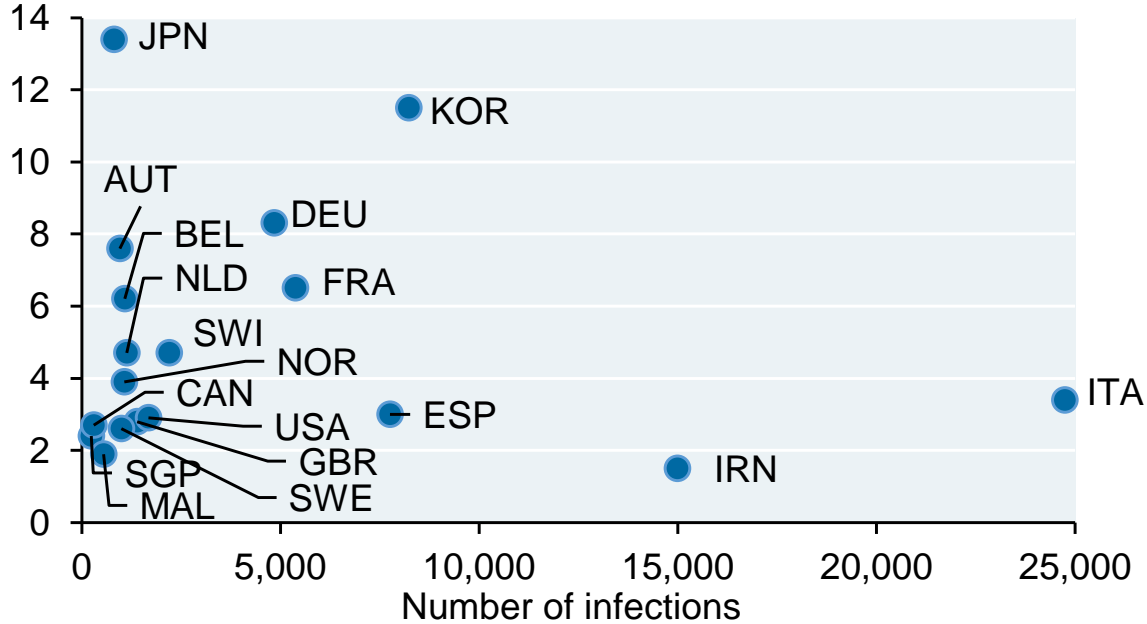
Faster public health response times =
lower mortality rates

- 100 years of history: get ahead of a pandemic
- Jan 1: Chinese officials required hospitals not to transfer fever patients to another medical facility, prevented doctors from publishing diagnosis and treatment information for COVID-19
- Jan 1: Chinese government punished doctors for discussing outbreak, required them to sign documents saying they were spreading lies
- Jan 14: Wuhan Health Commission reported that there were no new coronavirus cases, and that risk of human-to-human transmission is low
- During first three weeks of Jan, Wuhan hospitals didn't treat infected or asymptomatic outpatients as potentially infectious
- 40 infectious patients visiting clinics on Dec 31 ended up exposing 18,000 people before city shut down on Jan 23

Beds and testing

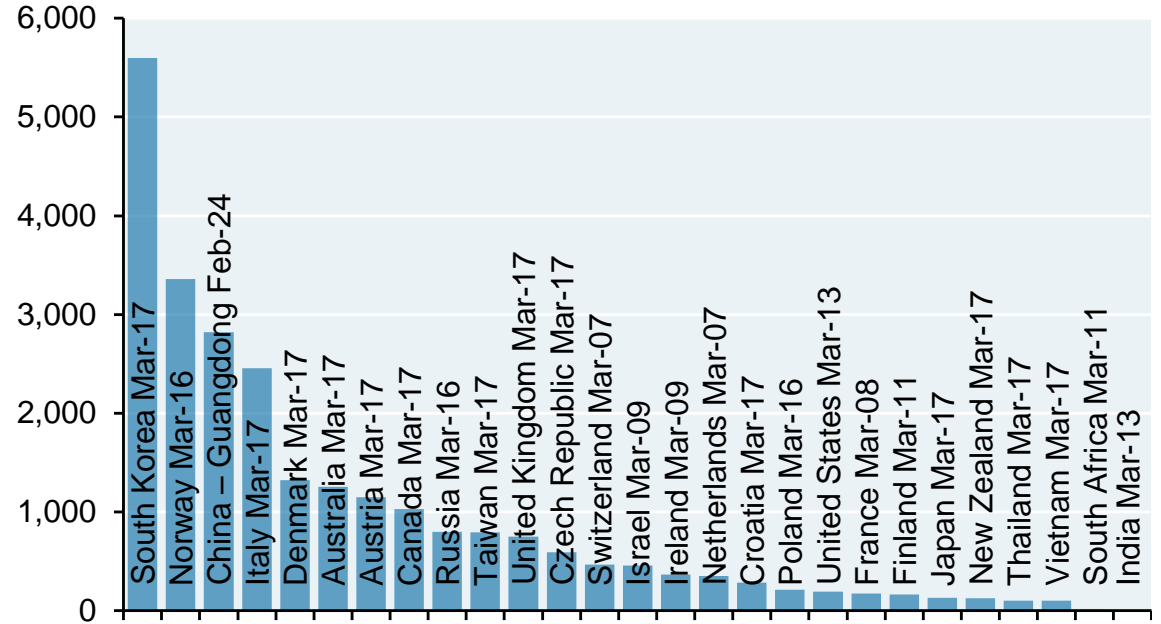
Hospital beds vs number of 2019-nCoV infections

Hospital beds per 1,000 people



Source: WHO, World Bank. March 16, 2020.

COVID-19 tests per million people

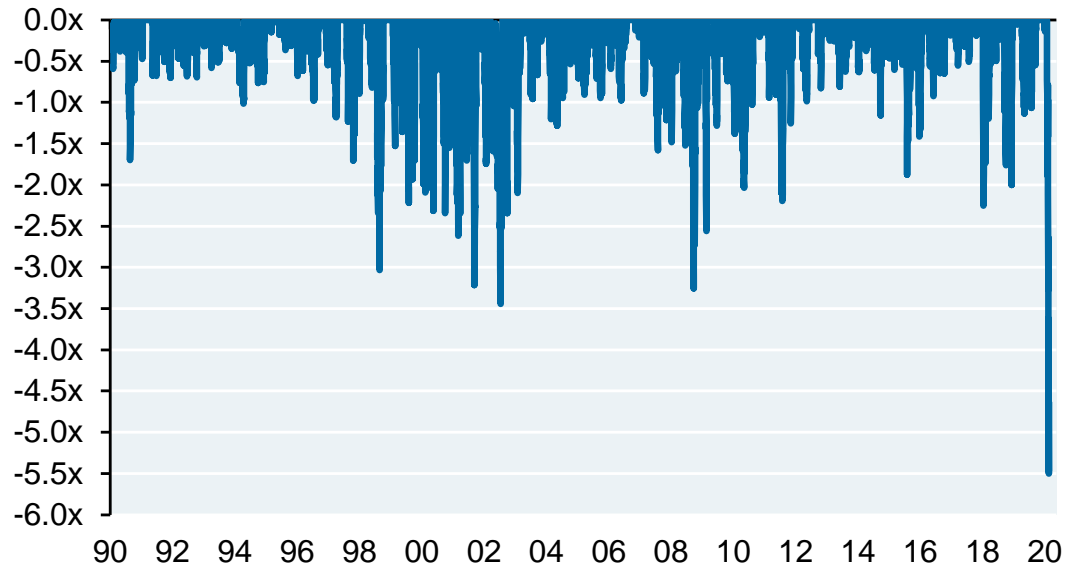


Source: Countries statistical reports by Esteban Ortiz-Ospina, IMF. Mar 17, '20

Equity markets

S&P 500 multiple derating

Forward 12 month P/E, difference versus previous month



Source: JPMAM, IBES, Datastream, Bloomberg. March 18, 2020.

S&P 500 price/earnings

Price / forward 12 month earnings per share

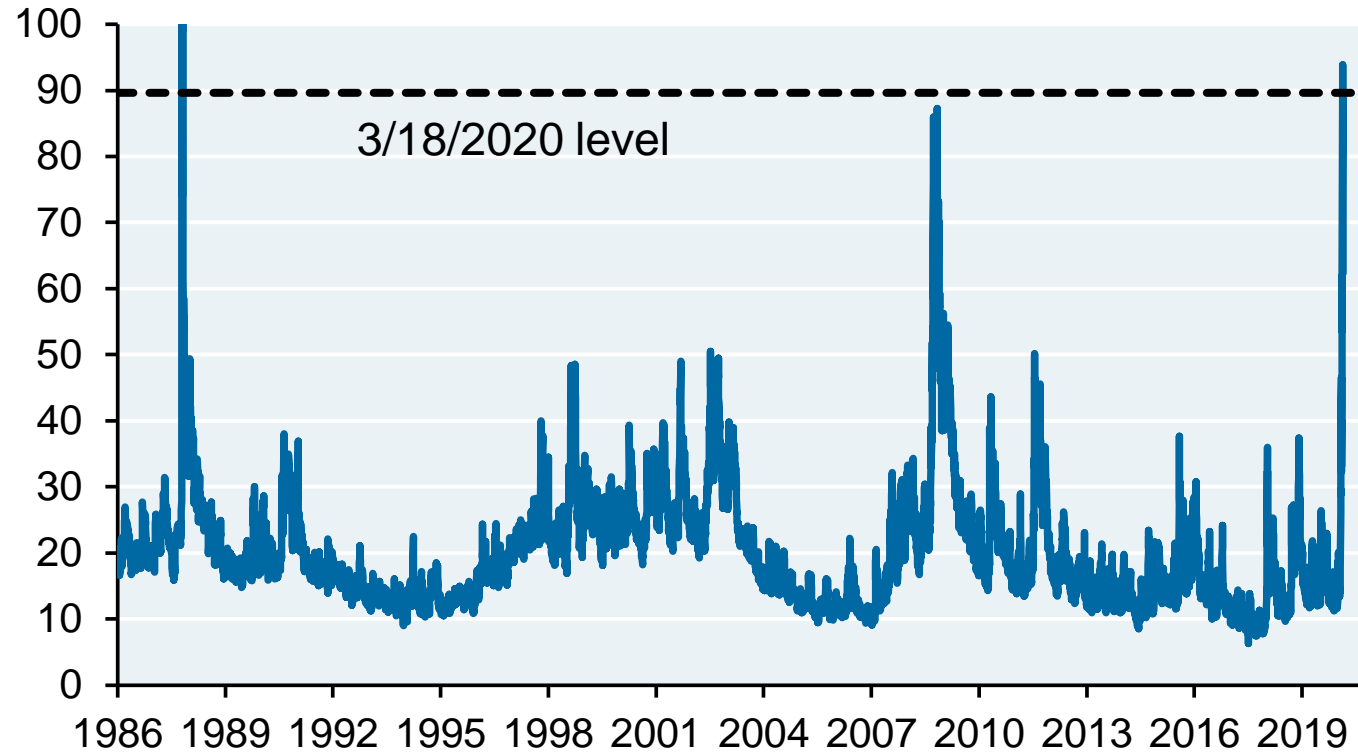


Source: JPMAM, IBES, Datastream, Bloomberg. March 18, 2020.

Equity markets

S&P 100 implied volatility index

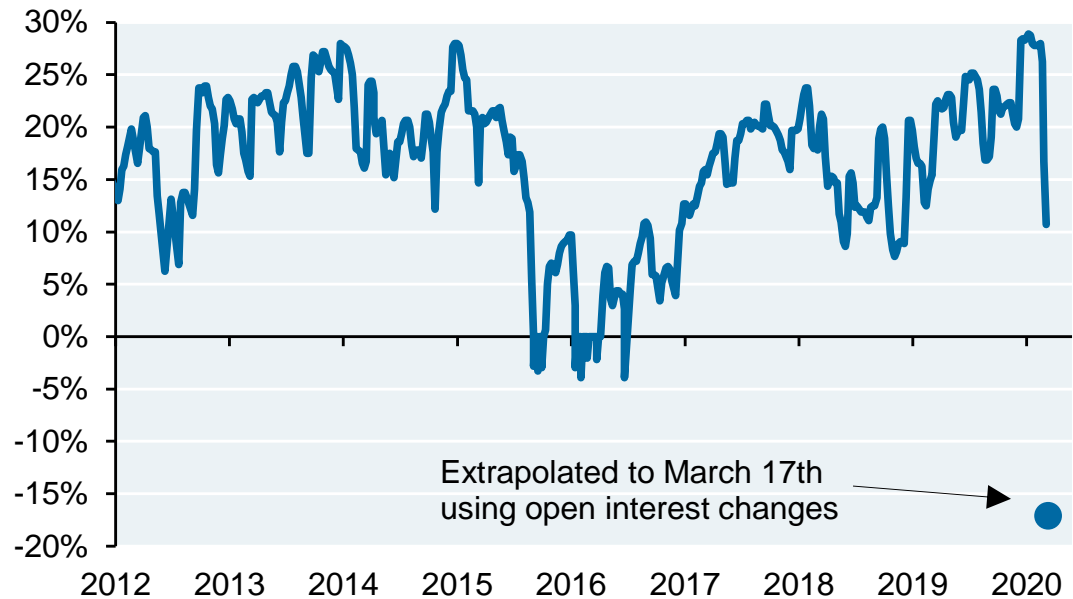
Index level



Source: Bloomberg. March 18, 2020.

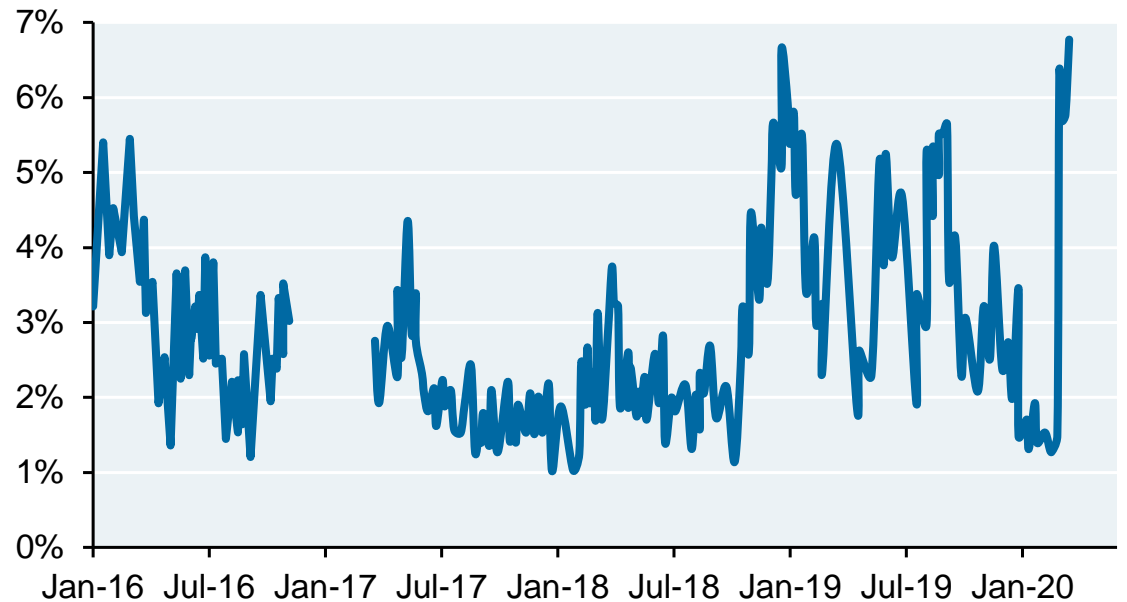
Equity markets

Positions in US equity futures by leveraged funds and asset managers, Spec positions as a percentage of open interest



Source: JPM Global Markets Strategy Flows & Liquidity. March 17, 2020.

Quantity-On-Loan of the SPY US ETF
On loan quantity as a % share of share outstanding



Source: JPM Global Markets Strategy Flows & Liquidity. March 16, 2020.

Credit markets

US investment grade corporate bond spreads

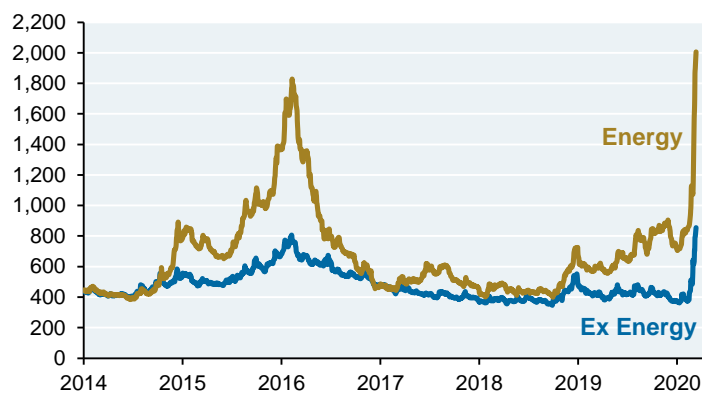
JULIS index, basis points



Source: Bloomberg, J.P. Morgan. March 18, 2020.

US high yield corporate bond spreads

JPDFHYI index energy and ex-energy, basis points



Source: Bloomberg, JPM HY Strategy team. March 18, 2020.

Emerging market sovereign bond spreads

JPSYAGSW index, basis points



Source: Bloomberg, J.P. Morgan. March 18, 2020.

Fixed rate preferred securities option adjusted spread

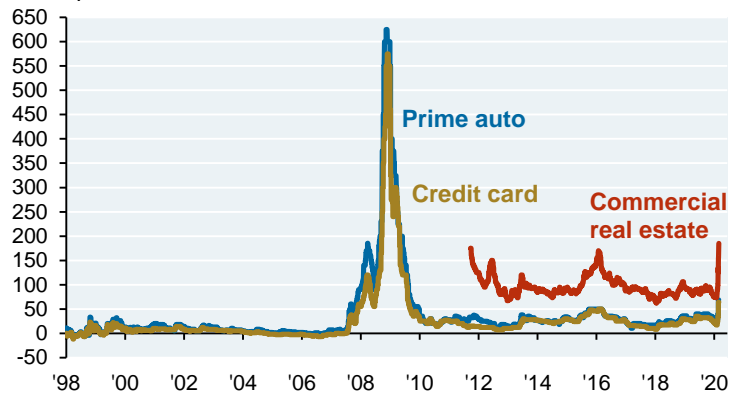
POP1 index, basis points



Source: Bloomberg. March 18, 2020

AAA asset backed securities spreads

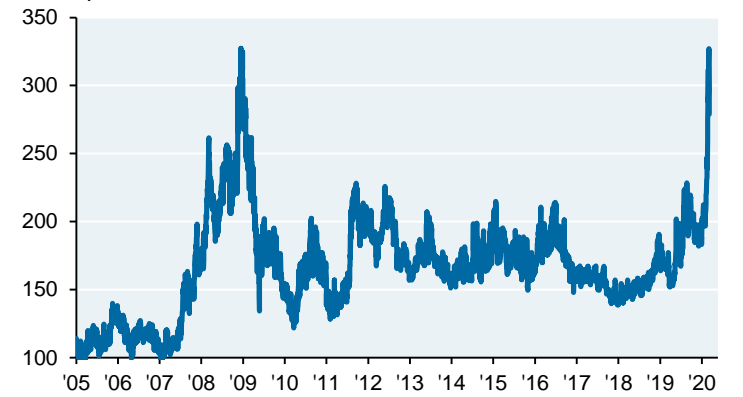
basis points



Source: J.P. Morgan. March 18, 2020.

30Y fixed mortgage - 10Y US Treasury

basis points



Source: Bloomberg. March 18, 2020.

Libor - federal funds rate

basis points



Source: Bloomberg. March 18, 2020.

Emergency facilities created by the Federal Reserve during the Financial Crisis

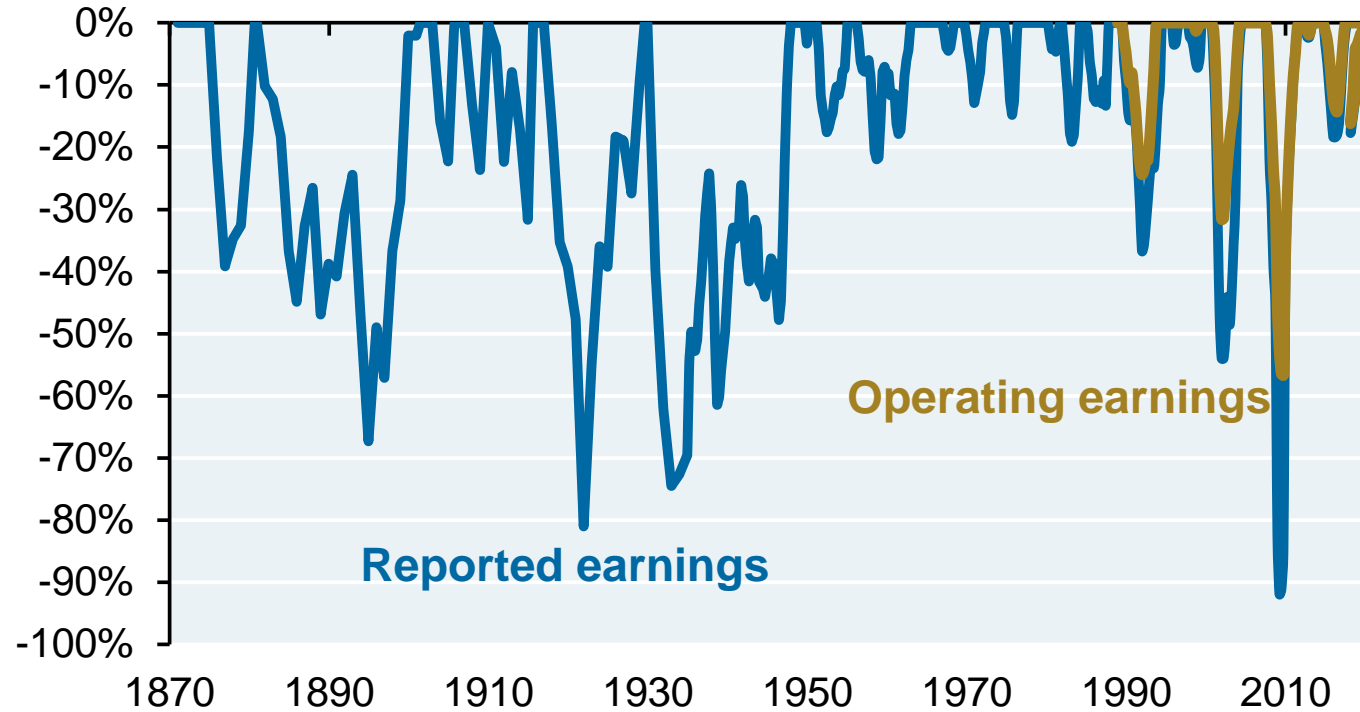
	Peak Outstanding Balance (\$ bn)
Term Auction Facility	\$493
Commercial Paper Funding Facility	\$348
Term Securities Lending Facility	\$236
Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility	\$152
Primary Dealer Credit Facility	\$147
Term Repurchase Transactions	\$80
AIG Revolving Credit Facility	\$72
Term Asset-Backed Securities Loan Facility	\$48

Source: Levy Economics Institute, Bard College. 2011.

How far do earnings fall in a recession?

S&P 500 earnings drawdowns

Maximum drawdown of earnings per share

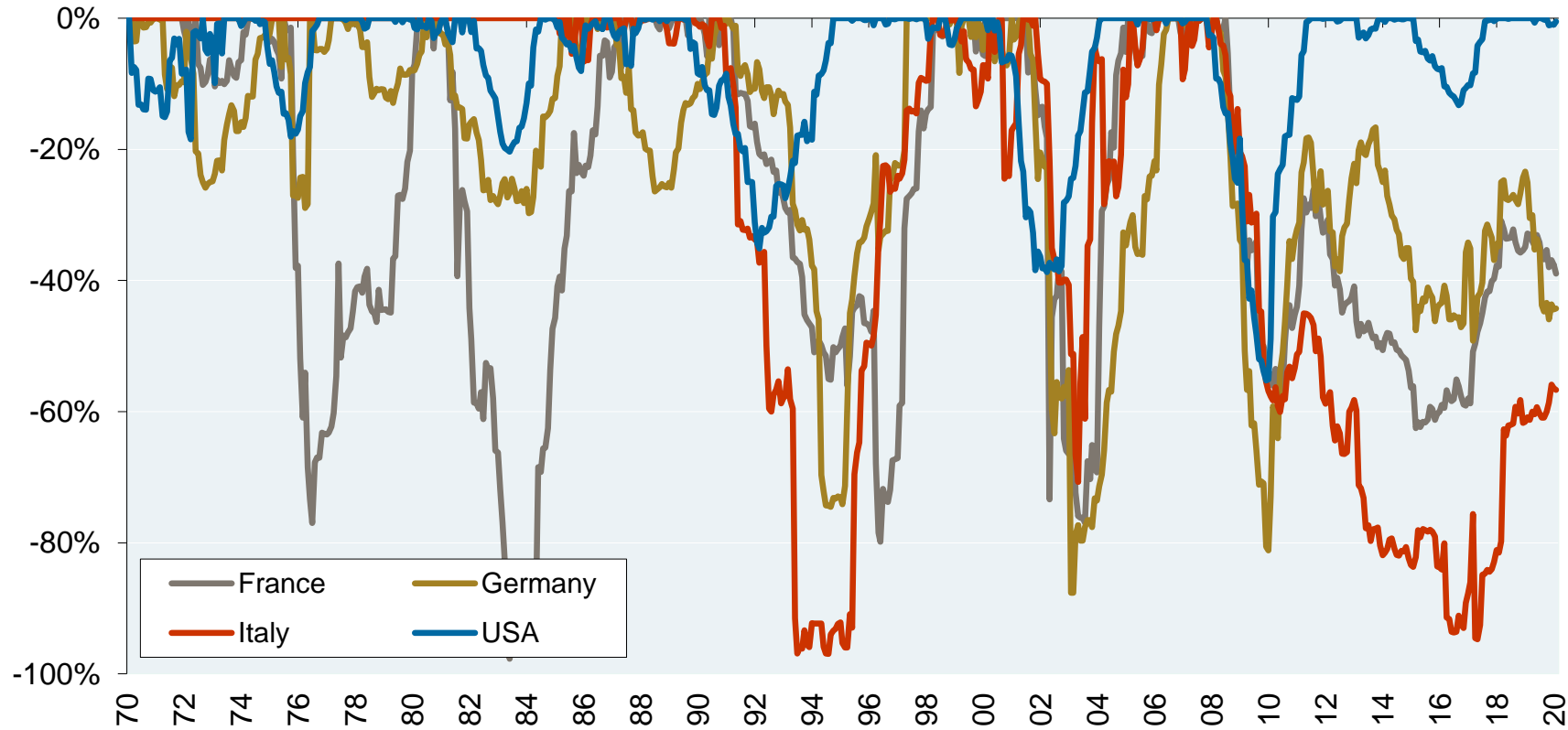


Source: Robert J. Shiller, S&P Dow Jones Indices. Q4 2019.

Earnings drawdowns, US vs Europe

European profits more sensitive to recessions

Maximum drawdown of earnings per share for respective MSCI country index

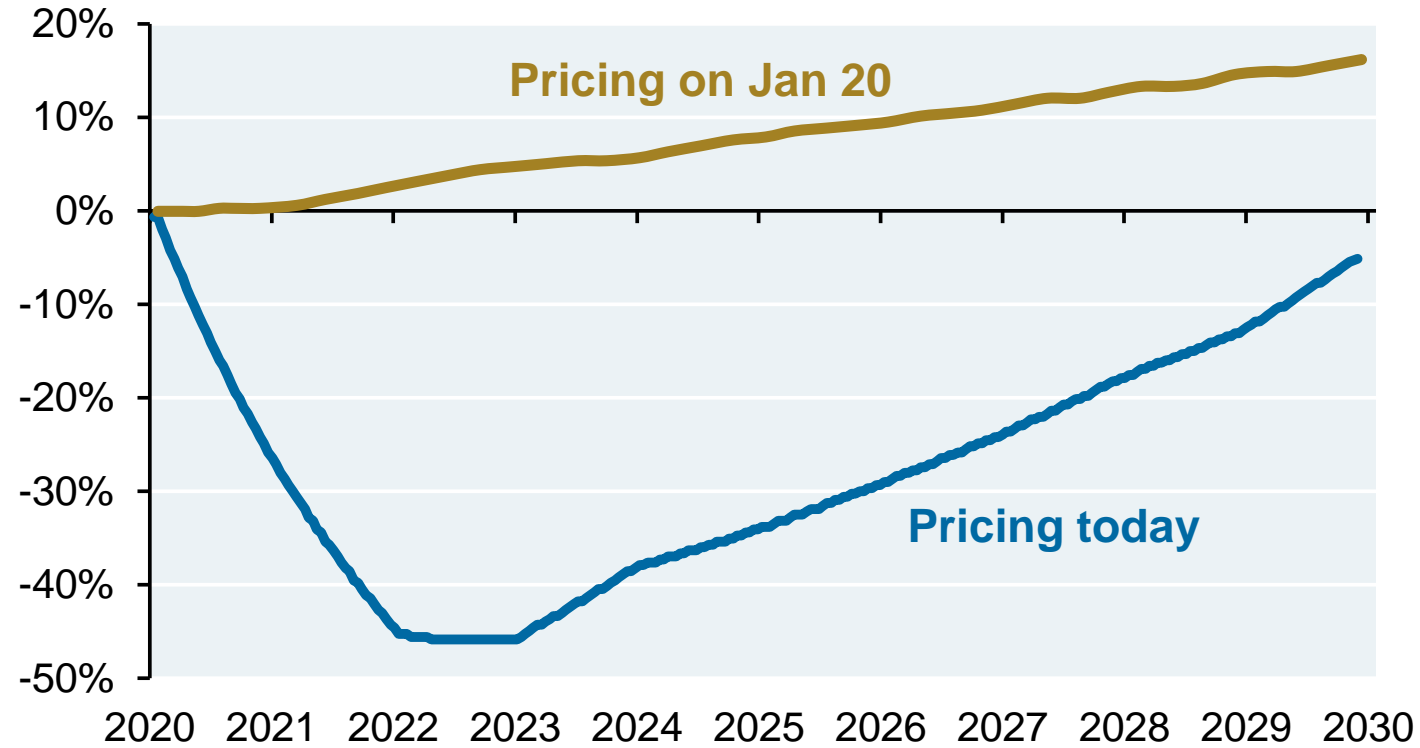


Source: J.P. Morgan Securities Inc., MSCI, Bloomberg. February 2020.

What are equity markets now pricing in regarding S&P 500 earnings?

US EPS level implied by dividend futures

% of pre-virus level



Source: Bridgewater. March 17, 2020.

What kind of crises play out over many years instead of over shorter periods?

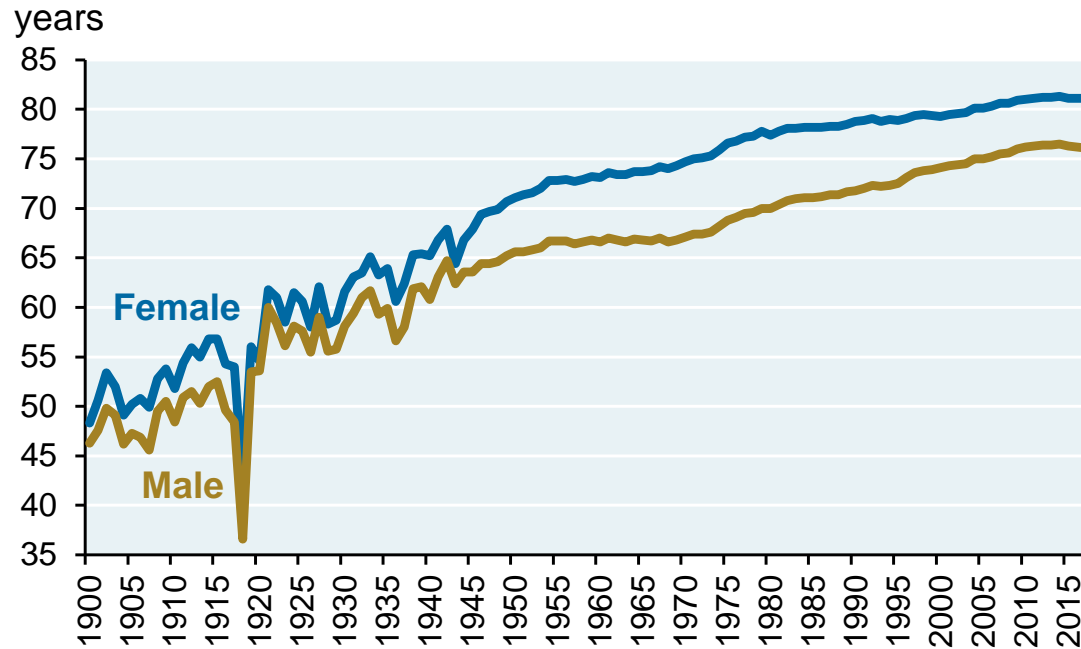
Time capsule: disaster, ruin and recovery

“What has so often excited wonder, is the great rapidity with which countries recover from a state of devastation, the disappearance in a short time, of all traces of mischief done by earthquakes, floods, hurricanes, and the ravages of war. An enemy lays waste a country by fire and sword, and destroys or carries away nearly all the moveable wealth existing in it: all the inhabitants are ruined, and yet in a few years after, everything is much as it was before.”

John Stuart Mill, *Principles of Political Economy*, 1848

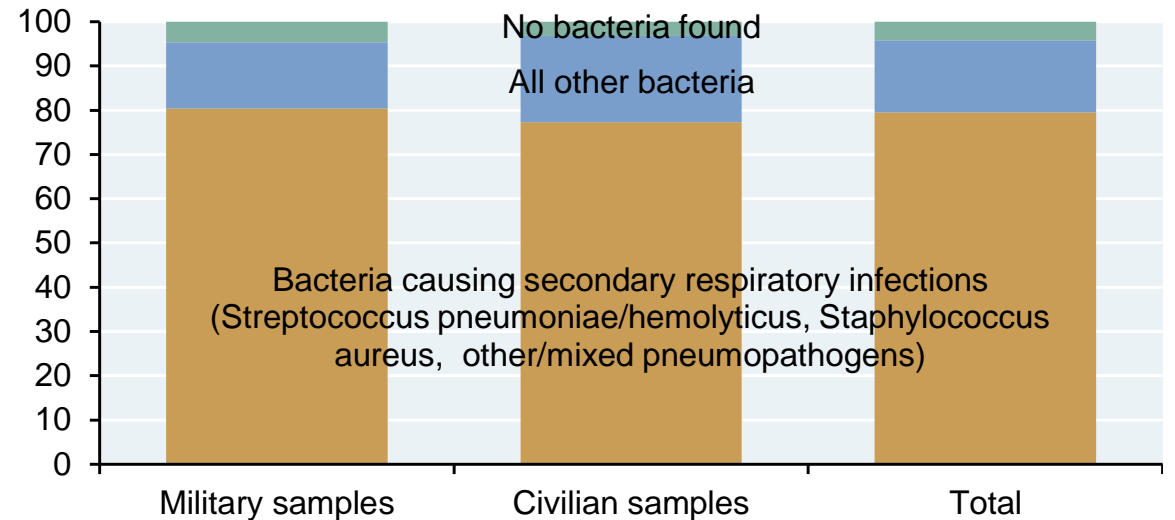
A lot has changed in medical science in 100 years

US life expectancy at birth



Source: US CDC; Andrew Noymer, Public Health Dep't, UC Irvine. 2020.

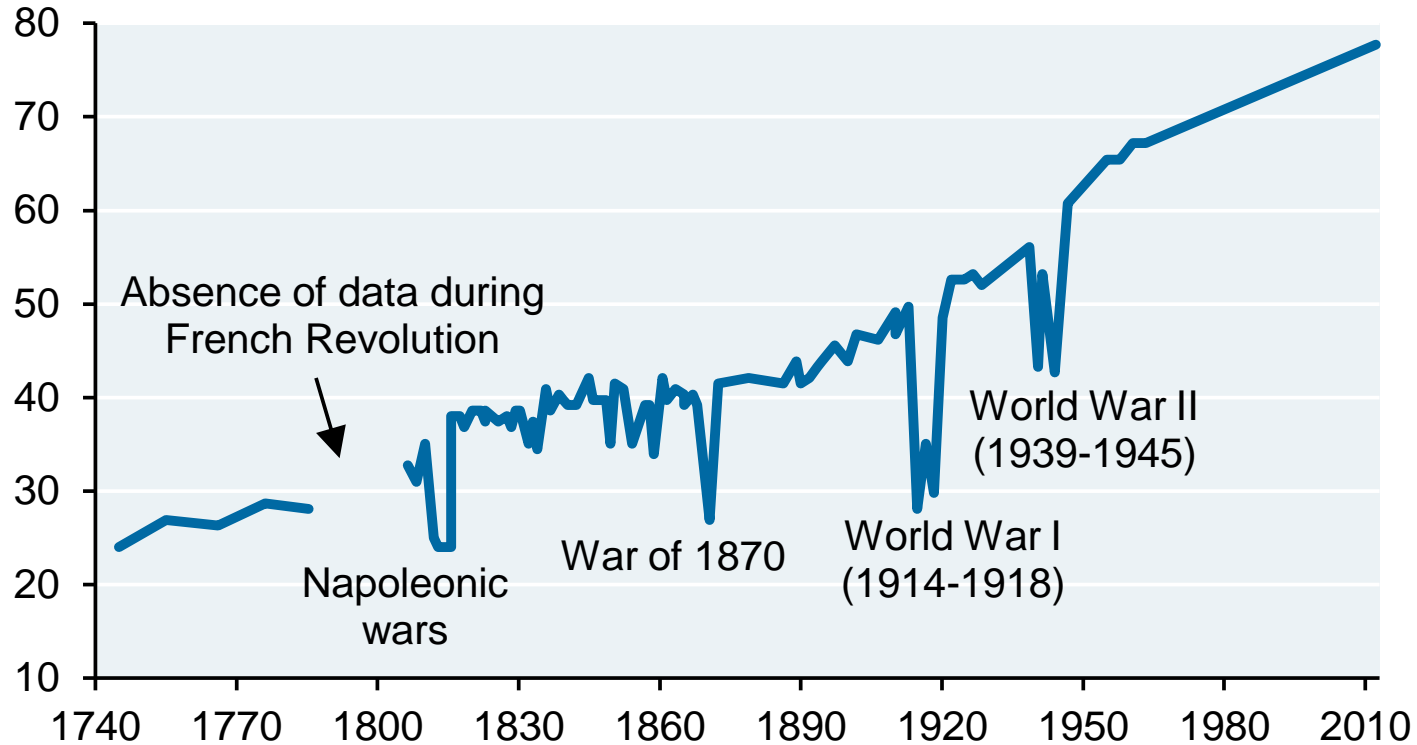
Spanish Flu (1918): % of cultures containing bacteria causing secondary respiratory infections/pneumonia



Source: "Predominant Role of Bacterial Pneumonia as a Cause of Death in Pandemic Influenza," National Institute of Allergy and Infectious Diseases, Morens et al, 2008

A lot has changed in medical science in 100 years

Male life expectancy in France years



Source: French Institute for Demographic Studies (INED). 2018.

This chart is a proxy for two things:

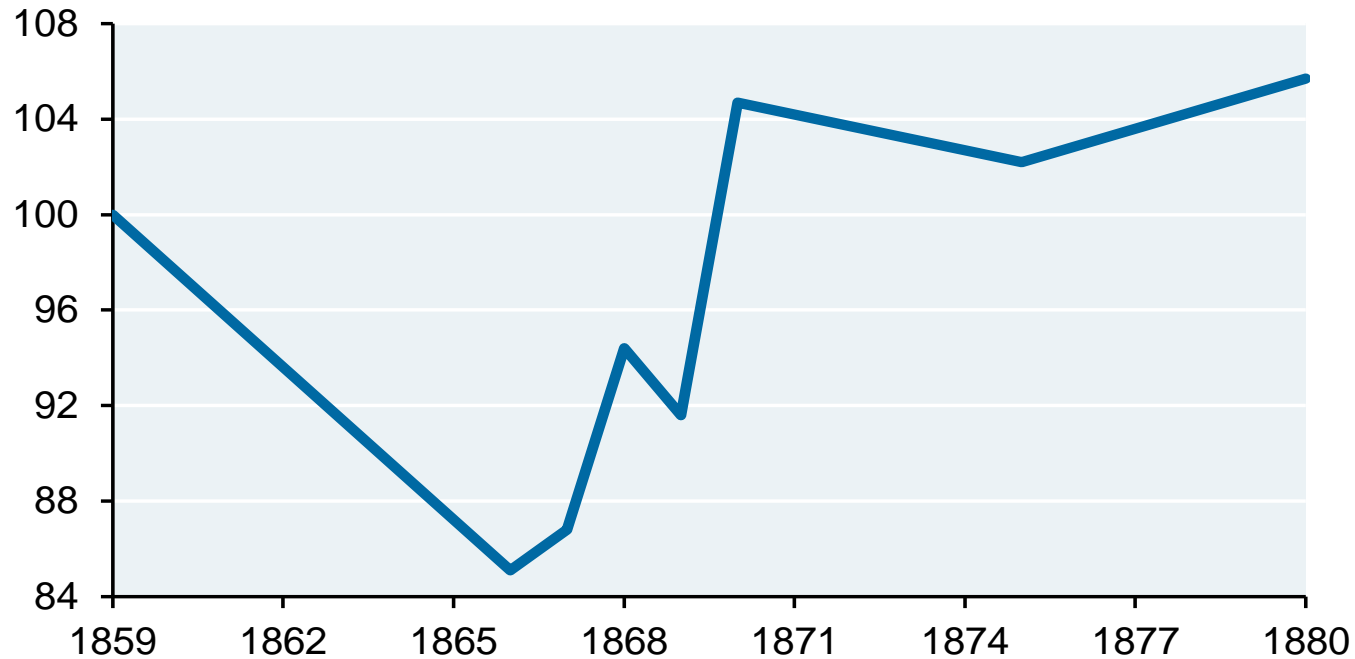
[1] astounding medical achievements of the 20th century, including tools scientists are now using to develop vaccines and anti-viral medications to combat COVID-19

[2] greater threats to life expectancy and prosperity have in modern times resulted less from pandemics and natural disasters, and more from what people do to each other in times of war

Time capsule: disaster, ruin and recovery

Post Civil War recovery in Confederate farm income

Index, 100 = 1859

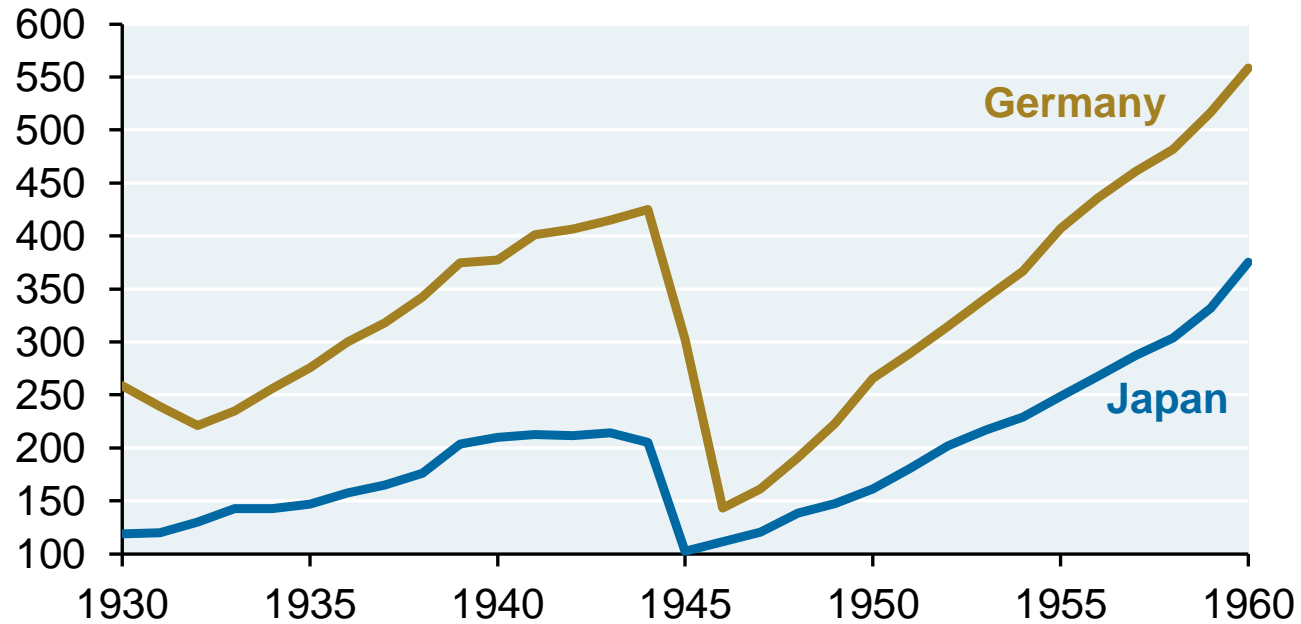


Source: "Economic Behaviour in Adversity", Jack Hirshleifer, The University of Chicago Press, 1987.

US Civil War: deadliest conflict in US history, with 6x mortality rate as World War II...it left the southern US in complete shambles... fought mostly on southern soil, leaving many cities in ruins with thousands of people lacking food, clothing, or shelter... Federal government did very little to assist them...and yet, look how quickly Confederate farm income rebounded after the war

What kind of crises require years for economies to recover? Colossal wartime destruction...

It took a full decade for Germany and Japan to recover from WWII, Real per capital GDP, 1990\$, thousands



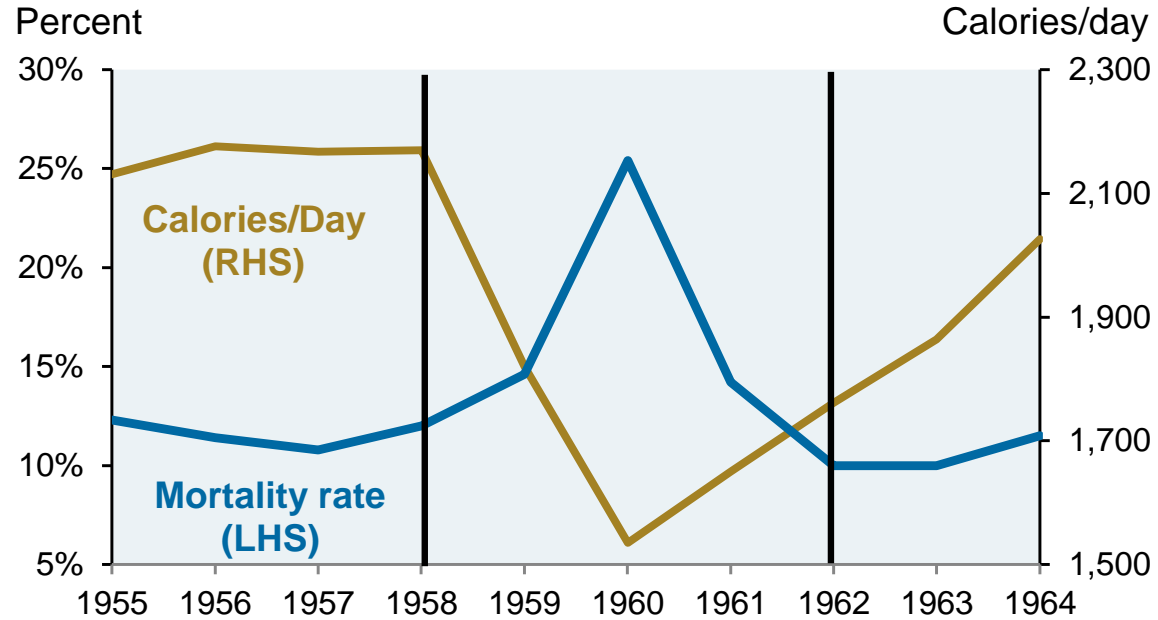
Source: Angus Maddison (Historical Statistics of the World Economy), JPMAM. 2020.

By 1945, 20% of Germany's housing stock was destroyed, food production was half of 1938 levels, industrial production was down by a third and caloric intake was around 1,250 calories per day (average American consumers 3,600 per day)

As for Japan, around 40% of its capital stock, a quarter of all housing and 180 miles of 67 cities were destroyed by the war

What kind of crises require years for economies to recover? Or colossal economic mismanagement...

China's disastrous *Great Leap Forward*



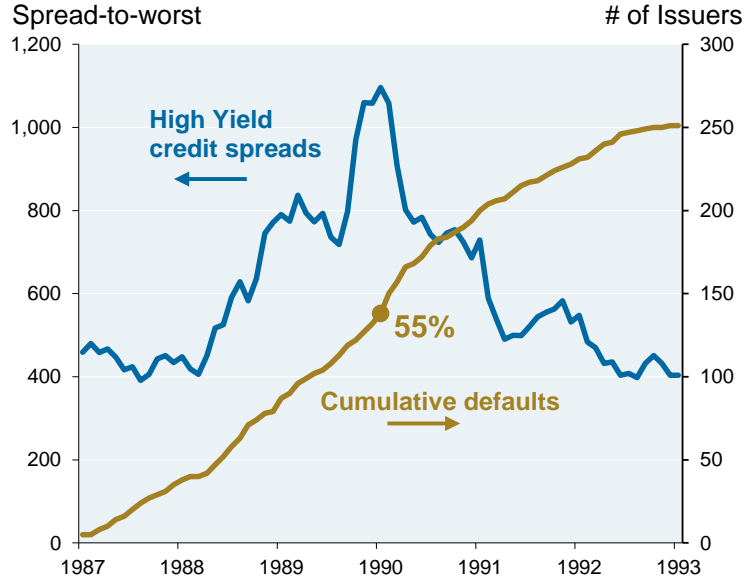
Source: "Visualizing the Effects of the Great Leap Forward", Basil Ashton, '84.

Dutch historian Frank Dikotter,
US historian R. Joseph Rummel:
Great Leap Forward was the largest
democide in human history

Concluding with a time capsule of markets bottoming
while fundamentals were still getting **worse**

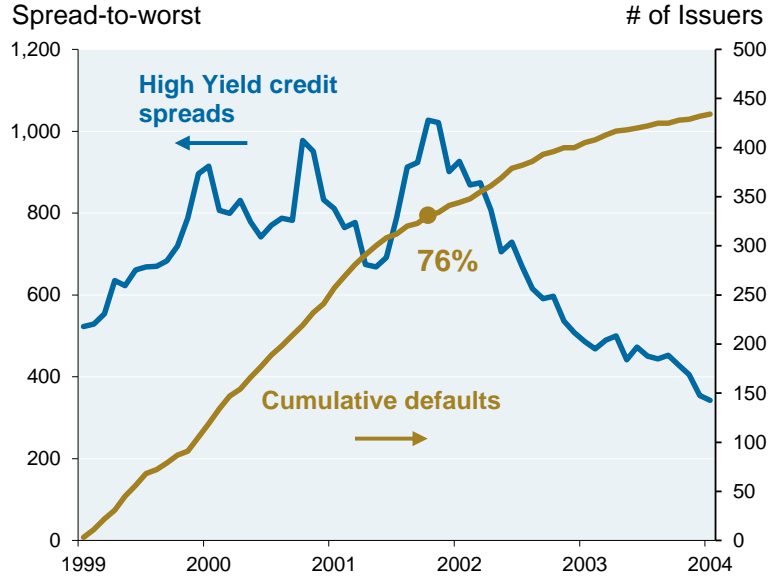
Time capsule: high yield markets tend to bottom well before defaults peak

Savings and Loan Crisis



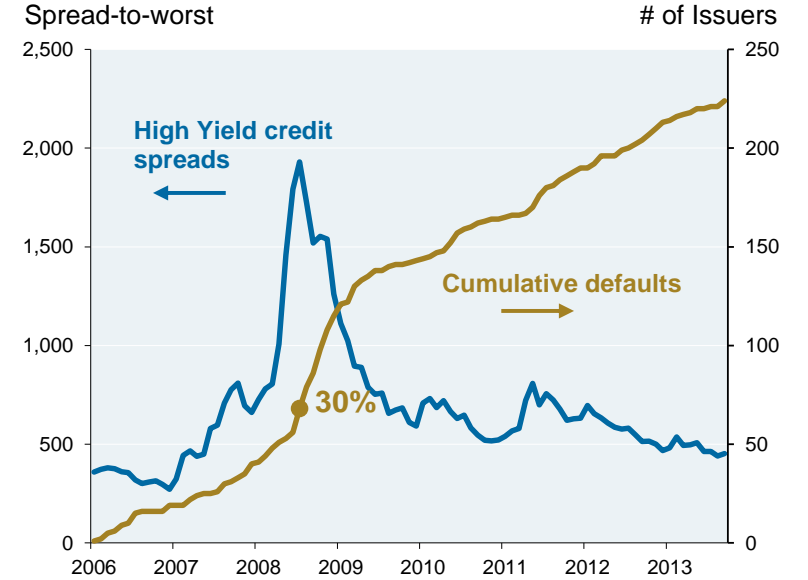
Source: J.P. Morgan Securities LLC. February 2014.

Tech collapse



Source: J.P. Morgan Securities LLC. February 2014.

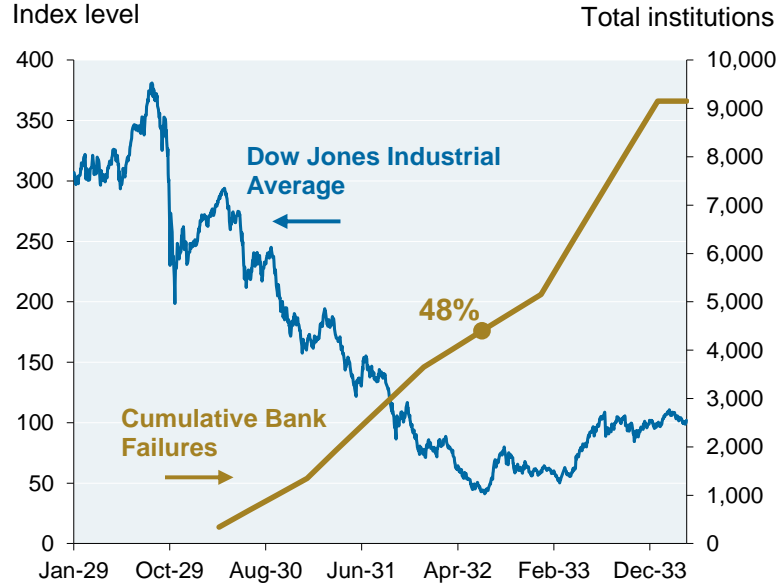
Financial crisis



Source: J.P. Morgan Securities LLC. February 2014.

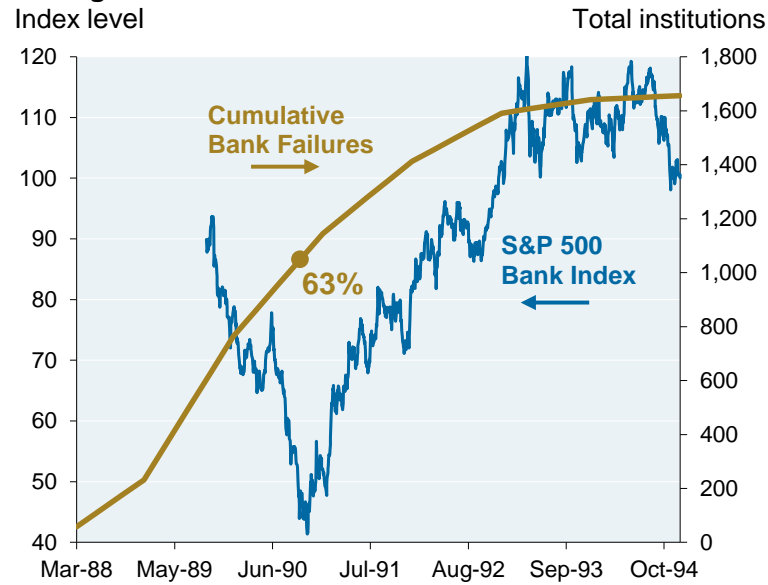
Time capsule: bank stocks tend to bottom well before the peak in bank failures

The Great Depression: Equity market vs. bank failures



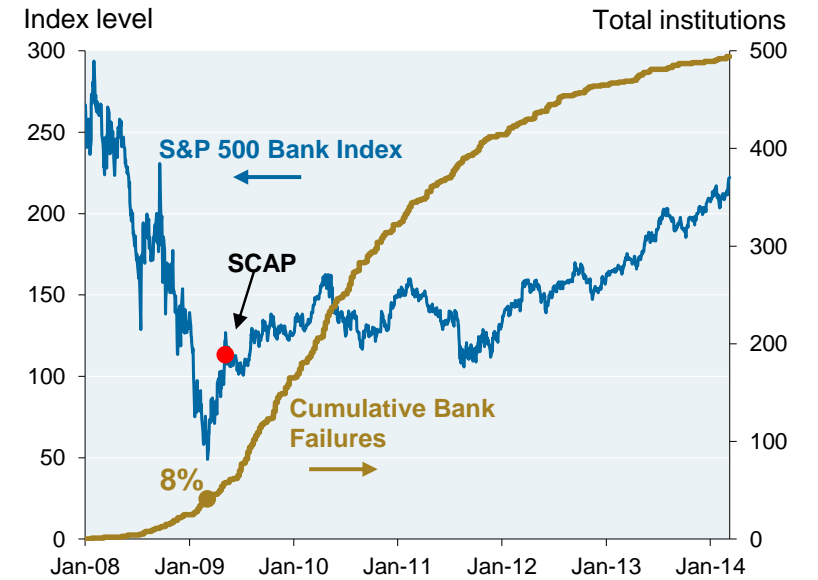
Source: FDIC, Bloomberg. March 2014.

Savings and Loan Crisis: Bank stocks vs. bank failures



Source: FDIC, Bloomberg. March 2014.

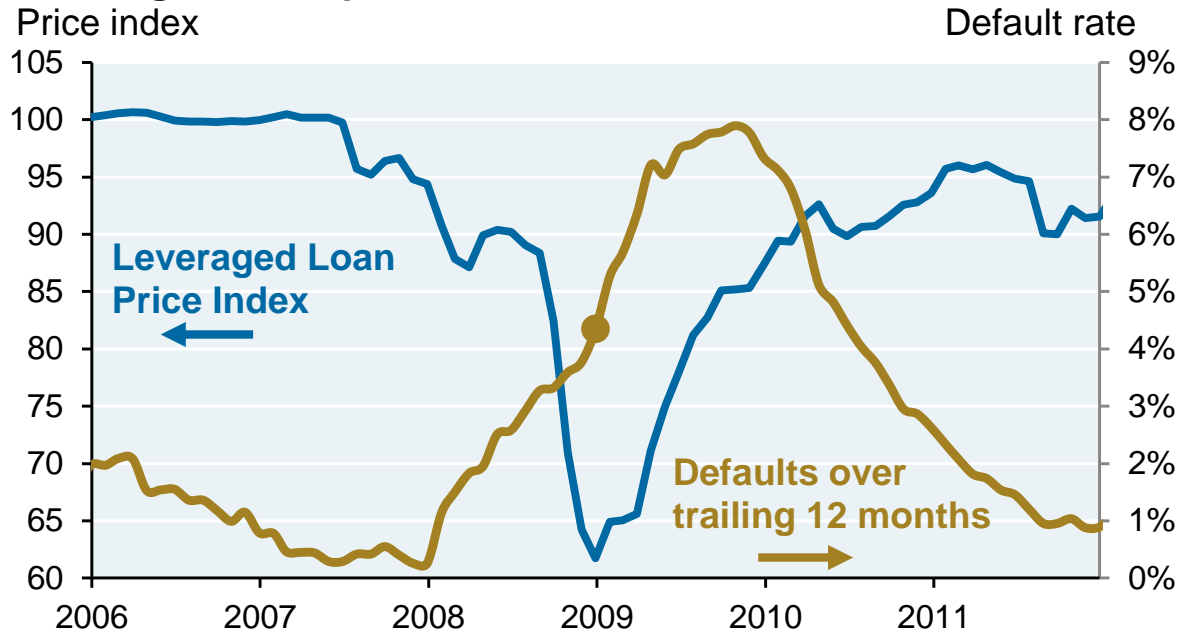
Financial crisis: Bank stocks vs. bank failures



Source: FDIC, Bloomberg. March 2014.

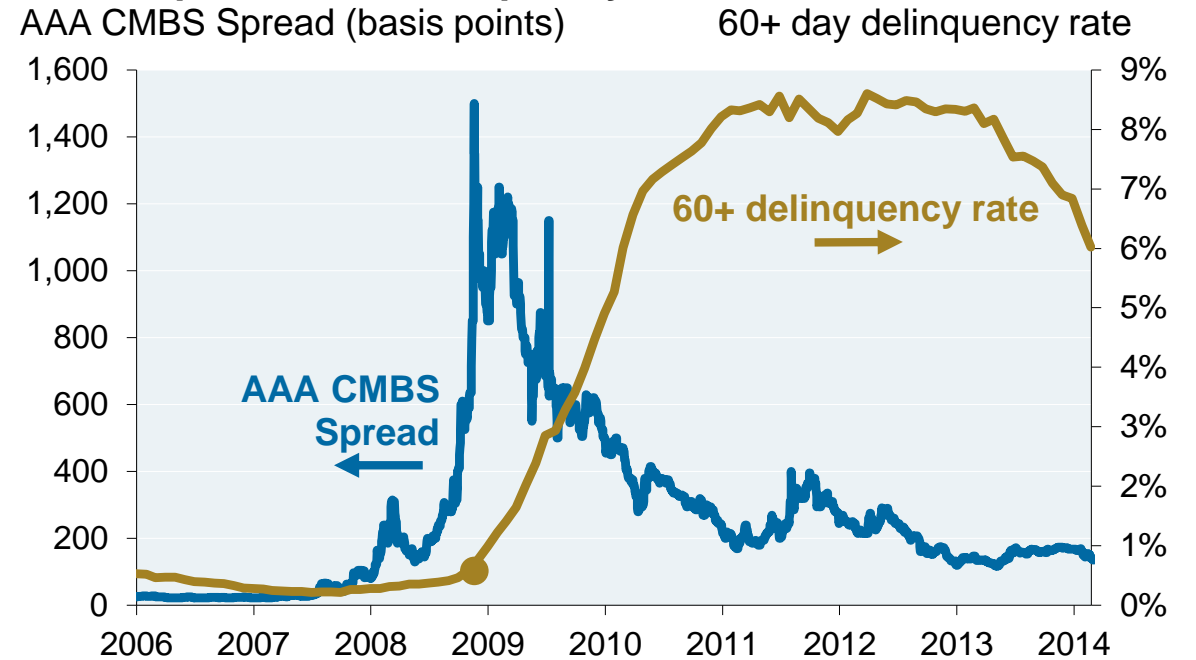
Time capsule: credit markets tend to bottom way before default rates peak

Leveraged Loan prices vs. defaults: 2006 to 2011



Source: J.P. Morgan Securities LLC, Standard and Poor's, S&P/LSTA Leveraged Loan Index. February 2014.

CMBS spreads vs. delinquency rates: 2006 to 2014



Source: Trepp, J.P. Morgan Securities LLC. February 2014.

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