A Presentation for Seattle City Light
March 24, 2020

Covid-19 and Infrastructure

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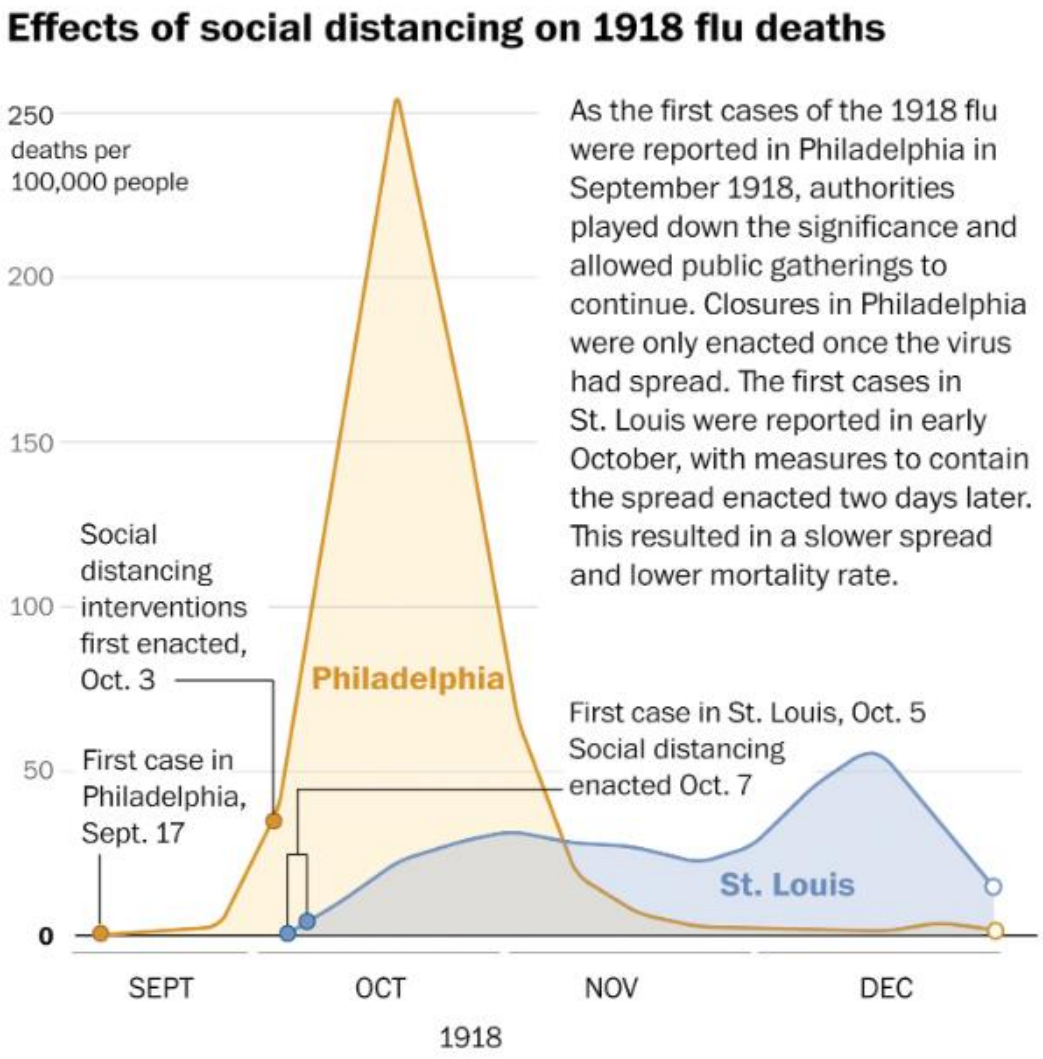

Sources: "Public health interventions and epidemic intensity during the 1918 influenza pandemic" by Richard J. Hatchett, Carter E. Mecher, Marc Lipsitch, Proceedings of the National Academy of Sciences May, 2007. Data derived from "Public health interventions and epidemic intensity during the 1918 influenza pandemic" by Richard J. Hatchett, Carter E. Mecher, Marc Lipsitch, Proceedings of the National Academy of Sciences May, 2007.

TIM MEKO/THE WASHINGTON POST

Philadelphia and St. Louis responded differently to the flu outbreak in 1918. (Tim Meko)

1918 H1N1 Influenza as a reference case

Covid-19 (SARS-CoV-2) is a novel virus
We have no immunity until we are either infected or vaccinated

Carolyn Y. Johnson, Lena H. Sun and Andrew Freedman
Washington Post, March 10, 2020,
https://www.washingtonpost.com/health/2020/03/10/social-distancing-coronavirus/

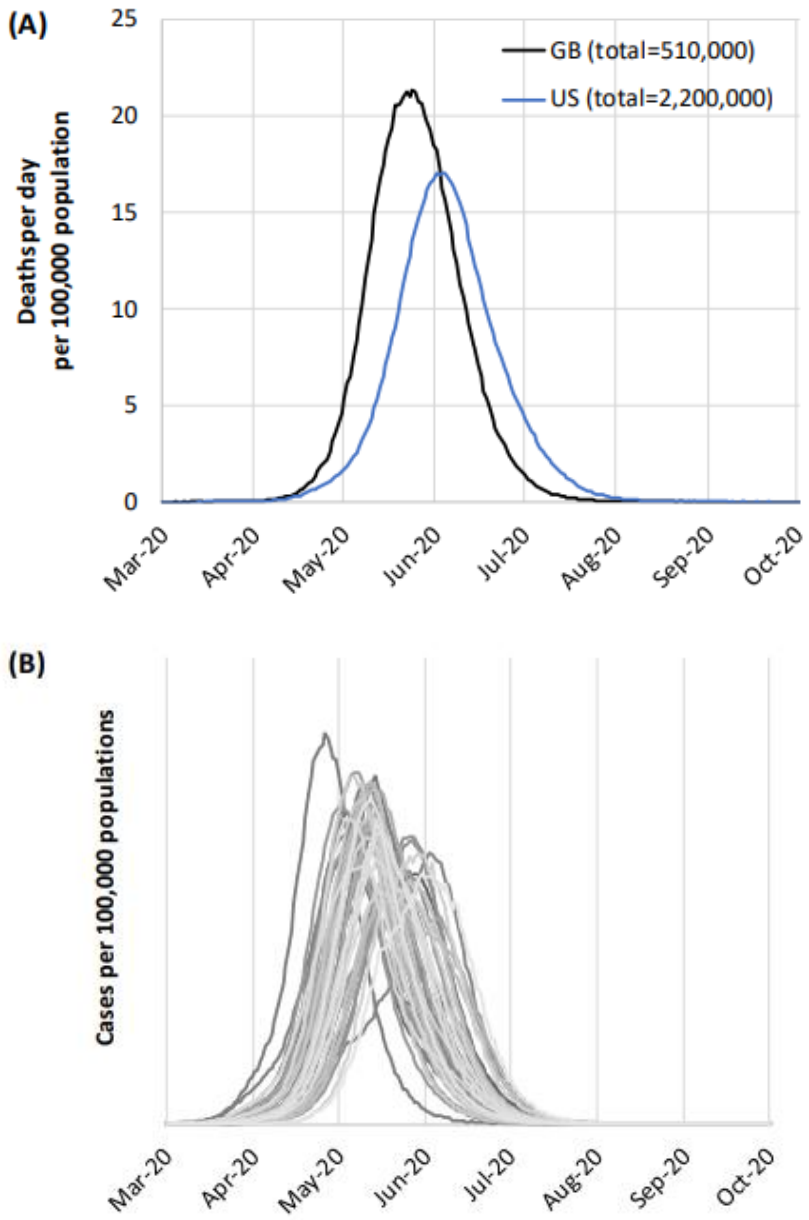

Figure 1: Unmitigated epidemic scenarios for GB and the US. (A) Projected deaths per day per 100,000 population in GB and US. (B) Case epidemic trajectories across the US by state.

"the public health threat it represents is the most serious seen in a respiratory virus since the 1918 H1N1 influenza pandemic."

In the (unlikely) absence of any control measures or spontaneous changes in individual behaviour, we would expect a peak in mortality (daily deaths) to occur after approximately 3 months (Figure 1A).

In such scenarios, **given an estimated R_0 of 2.4, we predict 81% of the GB and US populations would be infected over the course of the epidemic**. Epidemic timings are approximate given the limitations of surveillance data in both countries: The epidemic is predicted to be broader in the US than in GB and to peak slightly later. This is due to the larger geographic scale of the US, resulting in more distinct localised epidemics across states (Figure 1B) than seen across GB.

The higher peak in mortality in GB is due to the smaller size of the country and its older population compared with the US. In total, **in an unmitigated epidemic, we would predict approximately 510,000 deaths in GB and 2.2 million in the US**, not accounting for the potential negative effects of health systems being overwhelmed on mortality.

Neil M Ferguson, Daniel Laydon, Gemma Nedjati-Gilani, et al. *Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand* Imperial College COVID-19 Response Team, March 16, 2020. DOI: https://doi.org/10.25561/77482; https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

Table 2: Summary of NPI interventions considered.

Label	Policy	Description
CI	Case isolation in the home	Symptomatic cases stay at home for 7 days, reducing non-household contacts by 75% for this period. Household contacts remain unchanged. Assume 70% of household comply with the policy.
HQ	Voluntary home quarantine	Following identification of a symptomatic case in the household, all household members remain at home for 14 days. Household contact rates double during this quarantine period, contacts in the community reduce by 75%. Assume 50% of household comply with the policy.
SDO	Social distancing of those over 70 years of age	Reduce contacts by 50% in workplaces, increase household contacts by 25% and reduce other contacts by 75%. Assume 75% compliance with policy.
SD	Social distancing of entire population	All households reduce contact outside household, school or workplace by 75%. School contact rates unchanged, workplace contact rates reduced by 25%. Household contact rates assumed to increase by 25%.
PC	Closure of schools and universities	Closure of all schools, 25% of universities remain open. Household contact rates for student families increase by 50% during closure. Contacts in the community increase by 25% during closure.

Definitions of non-pharmaceutical interventions (NPI) and assumptions of the effects on rates of infection

Neil M Ferguson, Daniel Laydon, Gemma Nedjati-Gilani, et al. *Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand* Imperial College COVID-19 Response Team, March 16, 2020. DOI: https://doi.org/10.25561/77482; https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

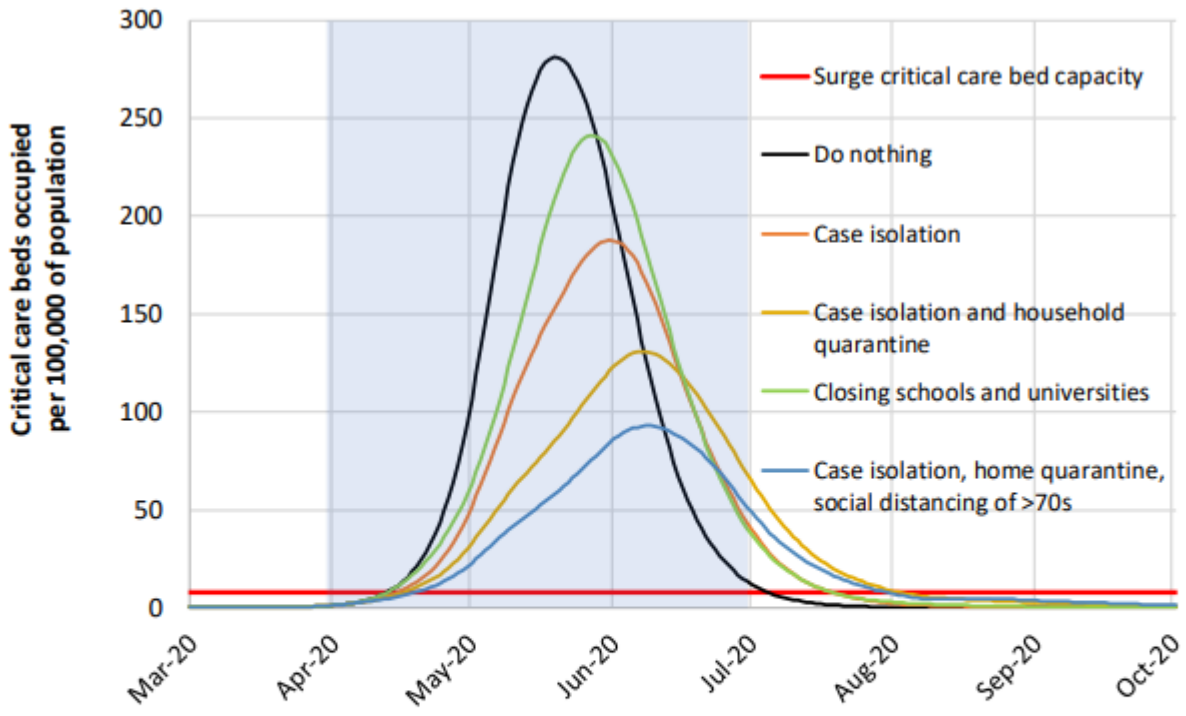

Figure 2: Mitigation strategy scenarios for GB showing critical care (ICU) bed requirements. The black line shows the unmitigated epidemic. The green line shows a mitigation strategy incorporating closure of schools and universities; orange line shows case isolation; yellow line shows case isolation and household quarantine; and the blue line shows case isolation, home quarantine and social distancing of those aged over 70. The blue shading shows the 3-month period in which these interventions are assumed to remain in place.

Modeling the effects of mitigation measures

The aim of mitigation is to reduce the impact of an epidemic by flattening the curve, reducing peak incidence and overall deaths (Figure 2).

For an uncontrolled epidemic, we predict critical care bed capacity would be exceeded as early as the second week in April, with an eventual peak in ICU or **critical care bed demand that is over 30 times greater than the maximum supply in both countries** (Figure 2). [Great Britain and US]

Since the aim of mitigation is to minimise mortality, the interventions need to remain in place for as much of the epidemic period as possible. Introducing such interventions too early risks allowing transmission to return once they are lifted (if insufficient herd immunity has developed); it is therefore necessary to balance the timing of introduction with the scale of disruption imposed and the likely period over which the interventions can be maintained.

Neil M Ferguson, Daniel Laydon, Gemma Nedjati-Gilani, et al. *Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand* Imperial College COVID-19 Response Team, March 16, 2020. DOI: https://doi.org/10.25561/77482; https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

Model assumptions, which can be expected to become more refined –revised– over time

We assumed **an incubation period of 5.1 days** [9,10]

Infectiousness is assumed to occur from 12 hours prior to the onset of symptoms for those that are symptomatic and from 4.6 days after infection in those that are asymptomatic with an **infectiousness profile over time that results in a 6.5-day mean generation time**.

Based on fits to the early growth-rate of the epidemic in Wuhan [10,11], we make **a baseline assumption that R_0=2.4** but examine values between 2.0 and 2.6.

We assume that **symptomatic individuals are 50% more infectious than asymptomatic individuals**.

Individual infectiousness is assumed to be variable, described by a gamma distribution with mean 1 and shape parameter gamma=0.25.

On recovery from infection, individuals are assumed to be immune to re-infection in the short term. Evidence from the Flu Watch cohort study suggests that **re-infection with the same strain of seasonal circulating coronavirus is highly unlikely in the same or following season** (Prof Andrew Hayward, personal communication).

Infection was assumed to be seeded in each country at an **exponentially growing rate (with a doubling time of 5 days) from early January 2020**, with the rate of seeding being calibrated to give local epidemics which reproduced the observed cumulative number of deaths in GB or the US seen by 14th March 2020

In other reports:

- pre-symptomatic individuals found to be highly infectious
  https://www.nature.com/articles/d41586-020-00822-x
- testing has lagged far behind actual rates of infection
- vaccination estimated at 12-18 months away

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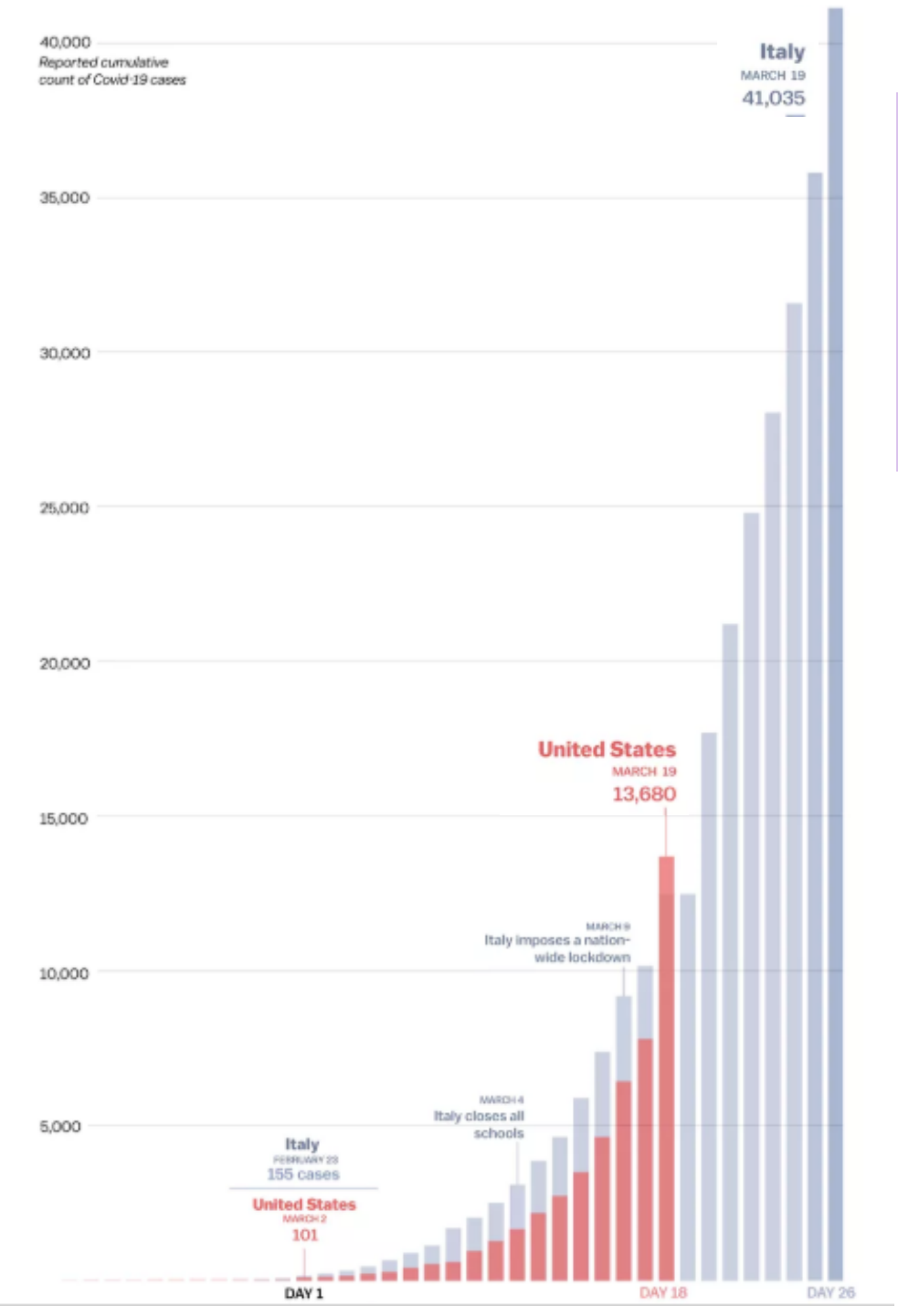

Actual Measures, US v. Italy, from Johns Hopkins Data Tracker

- **Herd immunity reached when 70-80% of the population are immune (either by transmission or vaccination)**
- **Flatten the curve so that people who are infected can get care.**
- **Buy time, and rapidly scale up (8x?) facilities and equipment.**

As the virus moves through the population, people are:

1) **Not yet infected**
2) **Infected** - individual severity varies
3) **Recovered** - and immune

WHO (*Situation Report 46*, March 6):

- 80% of infections are mild or asymptomatic
- 15% are severe infection, requiring oxygen
- 5% are critical infections, requiring ventilation

America's coronavirus curve looks a lot like Italy's

Note: Johns Hopkins data tracker did not report any new data for Italy on March 12
Source: 2019 Novel Coronavirus COVID-19 (2019-nCoV) Data Repository by Johns Hopkins CSSE

Christina Animashaun/Vox

https://www.vox.com/future-perfect/2020/3/20/21179040/coronavirus-us-italy-not-overreacting

Getting back to Normal

The world is not going to begin to look normal until three things have happened.

1. One, **we figure out whether the distribution of this virus looks like an iceberg, which is one-seventh above the water, or a pyramid, where we see everything**. If we're only seeing right now one-seventh of the actual disease because we're not testing enough, and we're just blind to it, then we're in a world of hurt.

2. **Two, we have a treatment that works, a vaccine or antiviral**.

3. **And three, maybe most important, we begin to see large numbers of people**—in particular nurses, home health care providers, doctors, policemen, firemen, and teachers who have had the disease—are **immune, and we have tested them to know that they are not infectious any longer. And we have a system that identifies them,** either a concert wristband or a card with their photograph and some kind of a stamp on it. Then we can be comfortable sending our children back to school, because we know the teacher is not infectious.

STEVEN LEVY, The doctor who helped defeat smallpox explains what's coming, WIRED.COM - 3/22/2020, 3:45 AM

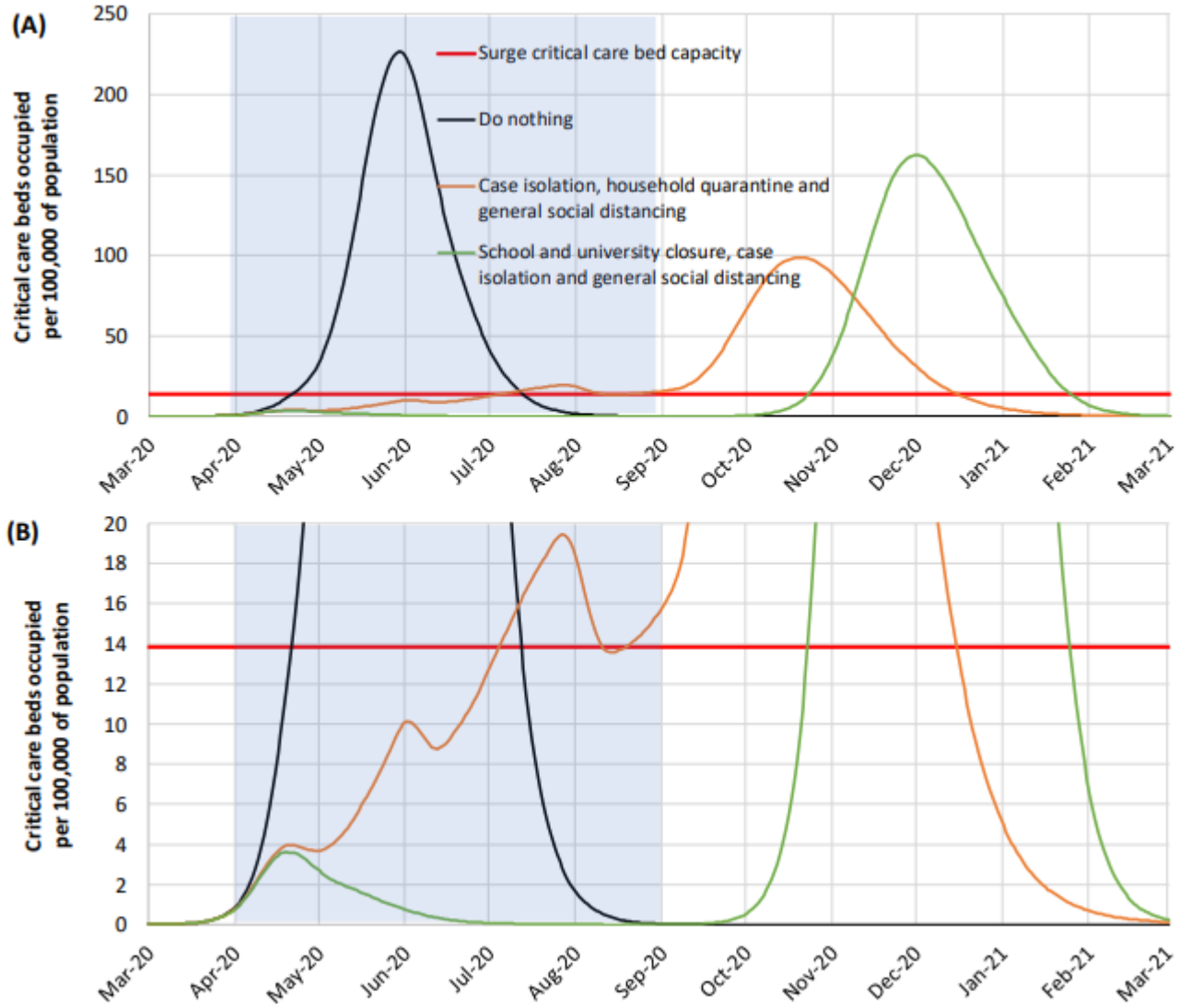

Figure A1: Suppression strategy scenarios for US showing ICU bed requirements. The black line shows the unmitigated epidemic. Green shows a suppression strategy incorporating closure of schools and universities, case isolation and population-wide social distancing beginning in late March 2020. The orange line shows a containment strategy incorporating case isolation, household quarantine and population-wide social distancing. The red line is the estimated surge ICU bed capacity in US. The blue shading shows the 5-month period in which these interventions are assumed to remain in place. (B) shows the same data as in panel (A) but zoomed in on the lower levels of the graph.

Model of Health Care Demand for the US

"comprehensive blended strategy" (WHO): Green + Orange

Critical care beds occupied per 100,000 persons
Grey zone: when the mitigation is in effect
Red line: number of beds of capacity
Black line: Do nothing
Green line: Suppression
Orange line: Containment

Minimize mortality - the interventions need to remain in place for as much of the epidemic period as possible.
How long can the intervention carry on? - balance the timing of introduction with the scale of disruption imposed and the likely period over which the interventions can be maintained.
Getting to herd immunity (70-80%) - The more successful a strategy is at temporary suppression, the larger the later epidemic is predicted to be in the absence of vaccination, due to lesser build-up of herd immunity.

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DOI: https://doi.org/10.25561/77482; https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

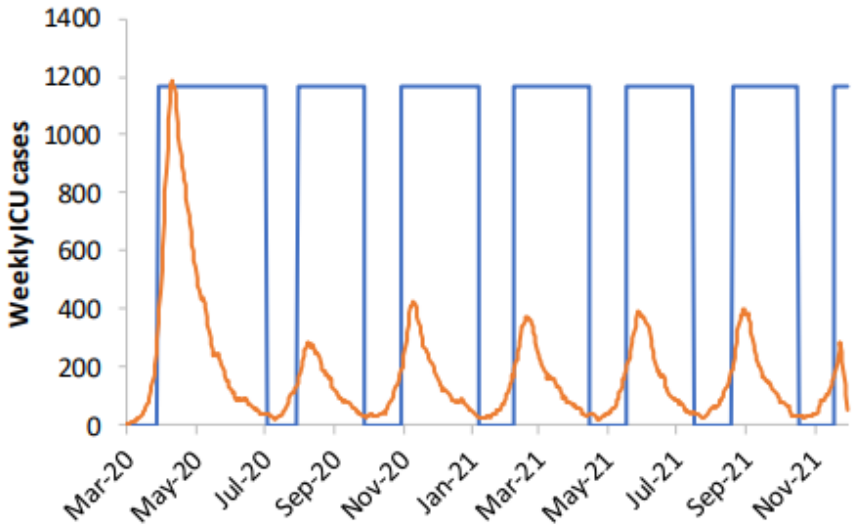


Figure 4: Illustration of adaptive triggering of suppression strategies in GB, for R_0=2.2, a policy of all four interventions considered, an "on" trigger of 100 ICU cases in a week and an "off" trigger of 50 ICU cases. The policy is in force approximate 2/3 of the time. Only social distancing and school/university closure are triggered; other policies remain in force throughout. Weekly ICU incidence is shown in orange, policy triggering in blue.

The Role of Interventions over Time

Blue: Policy is triggered
Orange: Weekly ICU incidence exceeds a trigger (100/week)

Adaptive policy in which social distancing (plus school and university closure, if used) is only initiated after weekly confirmed case incidence in ICU patients (a group of patients highly likely to be tested) exceeds a certain "on" threshold, and is relaxed when ICU case incidence falls below a certain "off" threshold.

Case-based policies of home isolation of symptomatic cases and household quarantine (if adopted) are continued throughout.

Neil M Ferguson, Daniel Laydon, Gemma Nedjati-Gilani, et al. *Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand* Imperial College COVID-19 Response Team, March 16, 2020. DOI: https://doi.org/10.25561/77482; https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

Researchers do know that **reinfection is an issue with the four seasonal coronaviruses that cause about 10 to 30% of common colds.** These coronaviruses seem to be able to sicken people again and again, even though people have been exposed to them since childhood.

"Almost everybody walking around, if you were to test their blood right now, they would have some levels of antibody to the four different coronaviruses that are known," says Ann Falsey of the University of Rochester Medical Center.

After infection with one of these viruses, she says, antibodies are produced but then the levels slowly decline and people become susceptible again.

That happens even though these viruses aren't as changeable as influenza, which mutates so quickly that a new vaccine has to be developed every year.

"We work with some common cold coronaviruses. We have samples from 30 years ago, strains that were saved from 30 years ago, and they're not appreciably different than the ones that are circulating now," says virologist Vineet Menachery of the University of Texas Medical Branch in Galveston.

Still, seasonal coronaviruses probably do mutate a bit over time to evade the body's defenses, says Frieman. But **there's little known about what those changes might look like, since researchers don't do annual surveillance of coronaviruses as they do for influenza.**

It's also possible that, for some reason, the body's immune response to seasonal coronaviruses is just not that robust or that something about the infection itself may inhibit the body's ability to develop long-term immunity.

NELL GREENFIELDBOYCE, Do You Get Immunity After Recovering From A Case Of Coronavirus? March 20, 2020
https://www.npr.org/sections/goatsandsoda/2020/03/20/819038431/do-you-get-immunity-after-recovering-from-a-case-of-coronavirus

How long does immunity last? (new normal?)

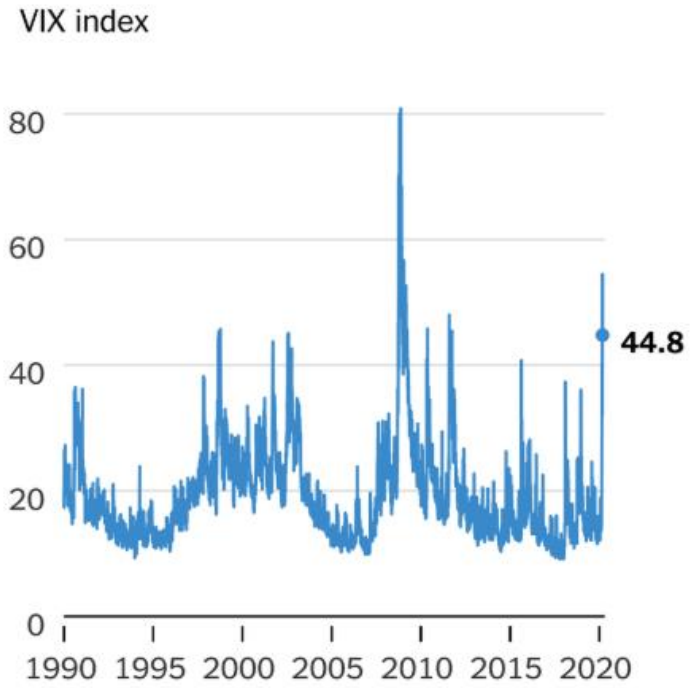
"**Most respiratory viruses only give you a period of relative protection. I'm talking about a year or two. That's what we know about the seasonal coronaviruses**," says Falsey.

Coronaviruses, much like influenza, tend to be winter viruses. In cold and dry air, the thin layers of liquid that coat our lungs and airways become even thinner, and the beating hairs that rest in those layers struggle to evict viruses and other foreign particles. Dry air also seems to dampen some aspects of the immune response to those trapped viruses.

At the moment, the virus is tearing through a world of immunologically naive people, and that vulnerability is likely to swamp any seasonal variations. After all, the new virus is transmitting readily in countries like Singapore (which is in the tropics) and Australia (which is still in summer). And one recent modeling study concluded that “SARS-CoV-2 can proliferate at any time of year.”

ED YONG, Why the Coronavirus Has Been So Successful
The Atlantic. MARCH 20, 2020.
https://www.theatlantic.com/science/archive/2020/03/biography-new-coronavirus/608338/

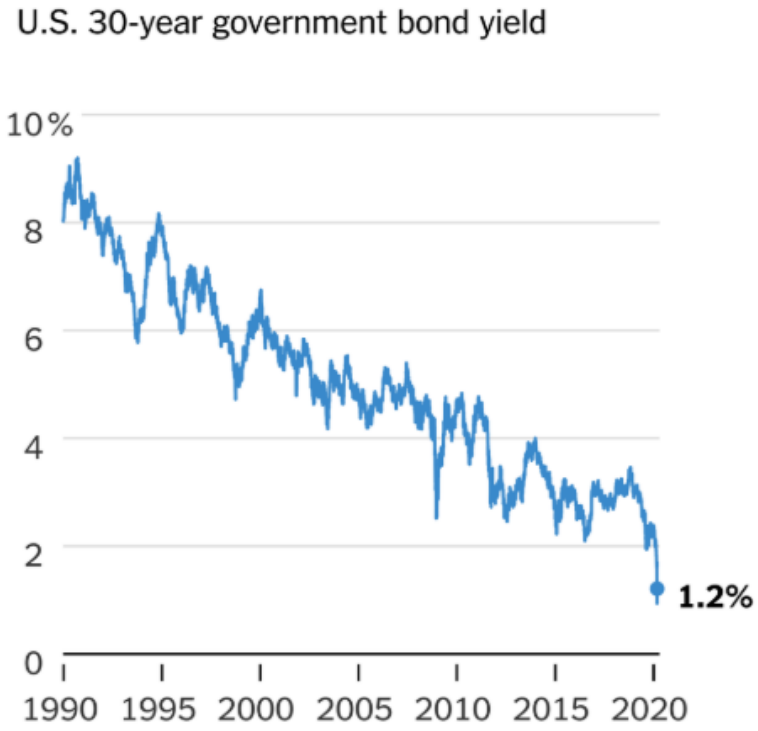
Market Reaction: Volatility and Investors Seeking Respite in Bond Finance



As of 6:15am ET on March 10, 2020
By The New York Times | Source: CBOE

Brutal volatility in the stock market has pushed up the VIX index, commonly called the market's "fear gauge."

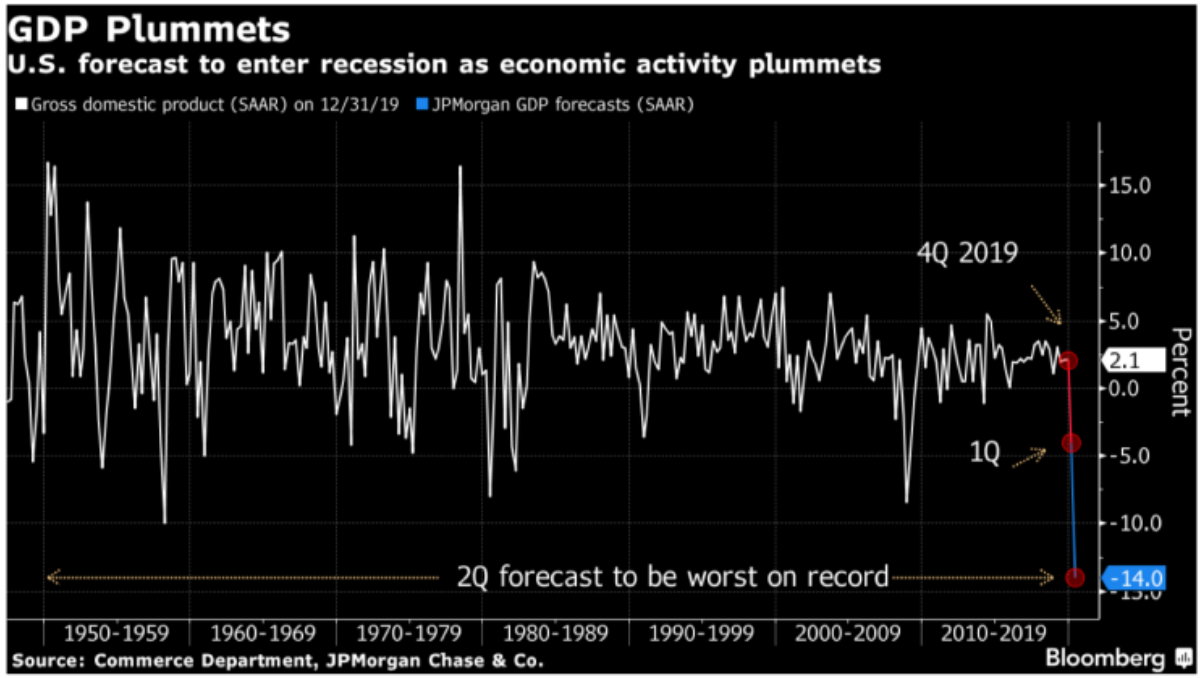
A measure of the 30-day implied volatility of the S&P 500 derived from out of the money options, https://www.bloomberg.com/news/articles/2020-03-09/traders-are-wagering-the-vix-hits-triple-digits-on-tuesday

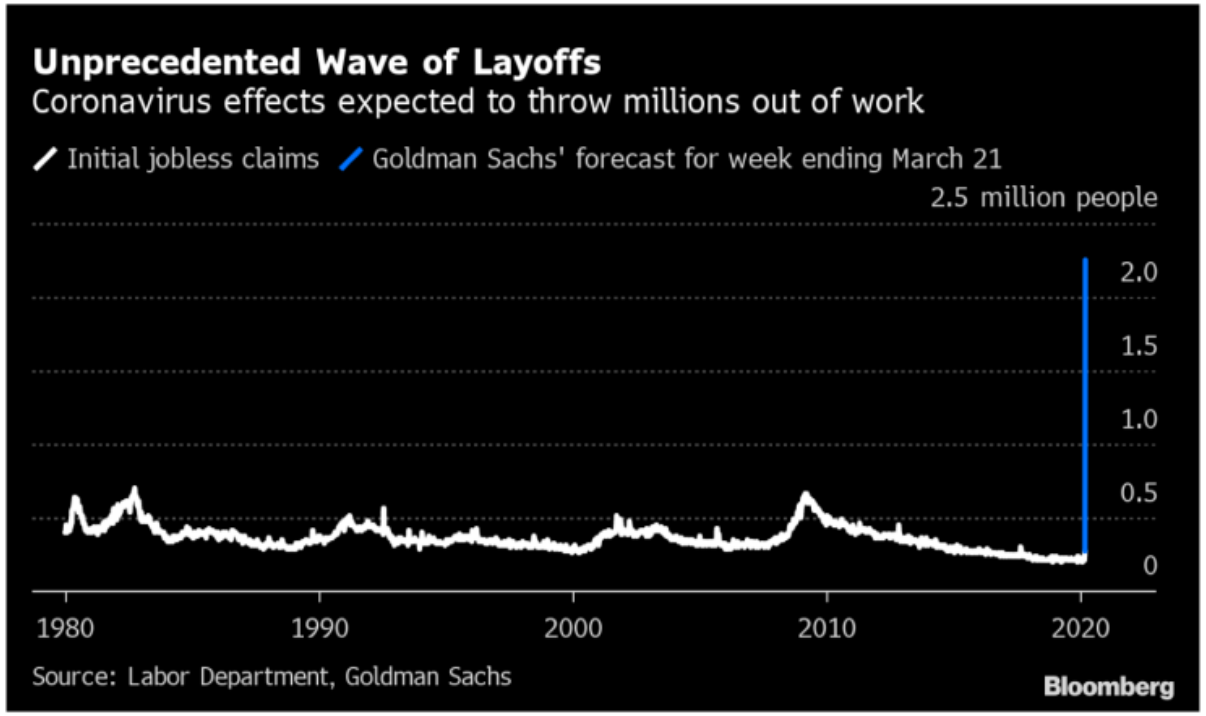


By The New York Times | Source: Investing.com

Seeking a safe place to park their money, investors have piled into U.S. government bonds. At one point yesterday, the 30-year Treasury yield fell so much that the entire curve at one point traded below 1 percent, less than the Fed's overnight benchmark rate. It's a sign of extreme stress and a signal that markets think significant rate cuts are on the cards.

Coronavirus Turmoil in 5 Charts, 10 Quotes, 5 Photos and 1 Map, March 10, 2020
https://www.nytimes.com/2020/03/10/business/dealbook/coronavirus-markets-oil.html





Production (supply) and Jobs (demand)

On Sunday evening, Goldman Sachs projected that economic growth would be zero in the first quarter of the year, which ends March 31, and that economic activity would fall by 5 percent in the second quarter. Just three days later, J.P. Morgan put out a new forecast: The gross domestic product would fall by 4 percent this quarter and then plummet a staggering 14 percent in the next three months.

"We're talking *really* big numbers," Heidi Shierholz, who served as chief economist for the Department of Labor during the Obama administration and is now a senior fellow at the Economic Policy Institute, a progressive think tank, told me on Thursday morning.

By Friday, Goldman Sachs had revised its figures: The investment bank was now expecting a 24 percent drop in the second quarter. "Holy hell," Shierholz said in an email flagging the update for me.

A nosedive along the lines of what J.P. Morgan is predicting, she told me, would mean that 8.5 million jobs would be lost by the summer, spiking the unemployment rate from its current 3.5 percent all the way up to roughly 8.7 percent. **Under the Goldman Sachs estimate, the jobs gone would total 14 million.** By comparison, a rough total of about 8.7 million jobs disappeared in the Great Recession a decade ago, but those losses were spread out over years. This would occur in a single springtime.

RUSSELL BERMAN The Economic Devastation Is Going to Be Worse Than You Think. The Atlantic. https://www.theatlantic.com/politics/archive/2020/03/covid-19s-devastating-effects-jobs-and-businesses/608461/

Top Economists See Some Echoes of Depression in U.S. Sudden Stop
The U.S. is entering a recession. The ultimate fear is that could turn into a protracted malaise that has some flavor of a depression. Bloomberg.com, March 22, 2020

A Supply AND Demand Problem

Multinational companies typically operate **complex supply chains**, with lean inventories and essential merchandise that often arrives just in the nick of time. That means **American companies that rely heavily on Chinese suppliers might begin facing shortages of key goods in the weeks ahead**, said Nada Sanders, professor of supply chain management at Northeastern University.

“I believe we’re going to have a massive shortage of goods,” she said. “Two weeks ago I told people this was coming. The big problem was **economists don’t understand how global supply chains work, how intertwined and interconnected they are**.” It is an issue she said would particularly affect pharmaceuticals and electronics.

Macroeconomic policies can’t really do anything about supply shocks like those. But it’s possible that supply shocks can bleed into demand shocks, and there economic policy can help.

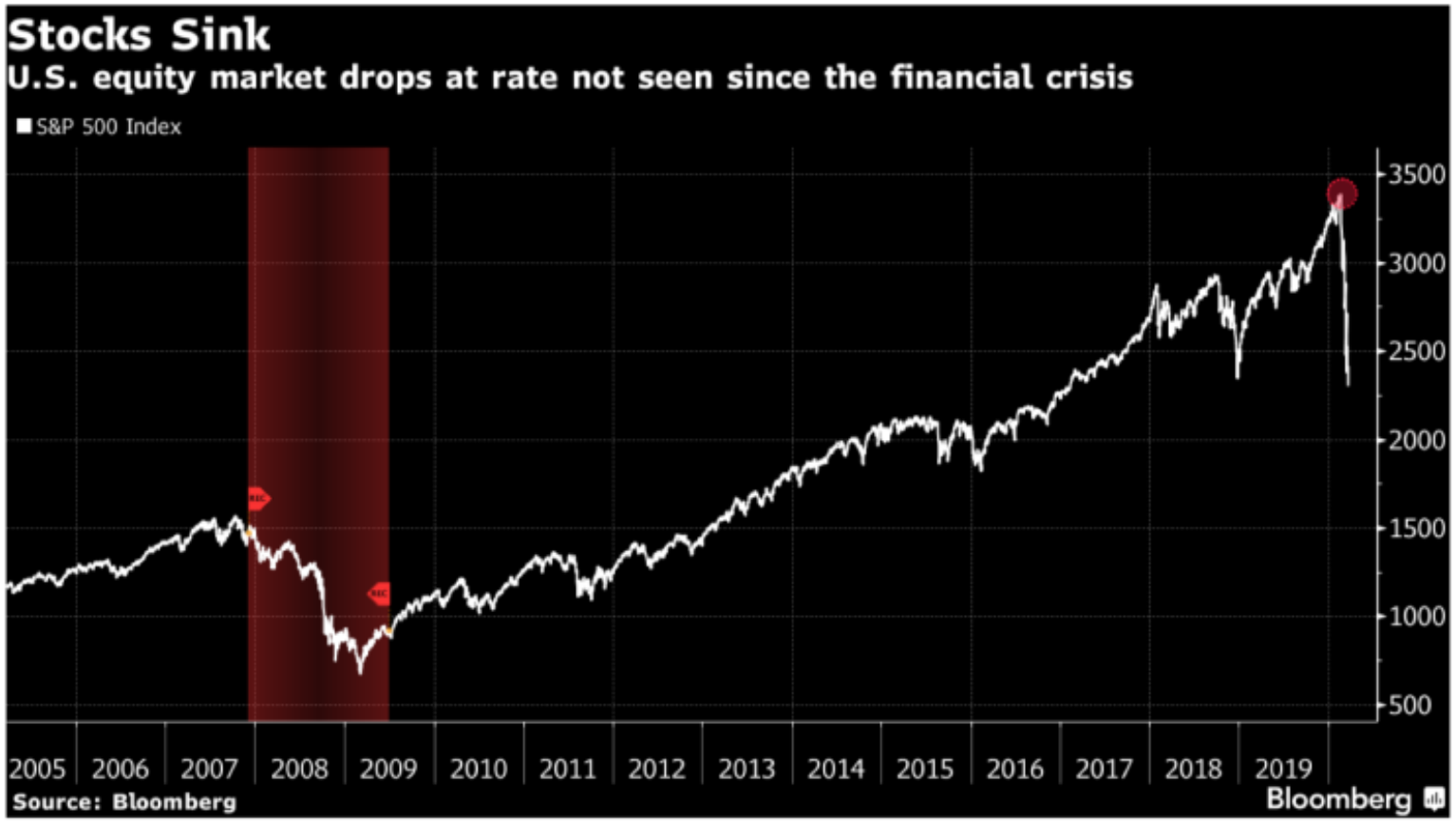
Tara Sinclair, who studies business cycles at George Washington University, compares it to a grocery store. **A store with no goods on the shelves has a supply problem, while a store with full shelves but no customers has a demand problem**. And it is generally easier to boost short-term demand than short-term supply.

But supply problems can bleed into demand problems, and vice versa.

“If first the store is empty of products, and then people don’t go to the store anymore and they lose their jobs, they can’t buy anything,” Ms. Sinclair said. “That’s what we’re risking here.”

Similarly, businesses might go bankrupt if the financial markets freeze up and they cannot get access to credit, meaning otherwise sound businesses end up laying off employees or closing down.

Neil Irwin, Why a Coronavirus Recession Would Be So Hard to Contain New York Times, Feb. 29, 2020Updated March 2, 2020, https://www.nytimes.com/2020/02/29/upshot/coronavirus-recession-US.html



Yet what is scariest about the new economic projections is that they are probably too rosy. Both Goldman Sachs and J.P. Morgan foresee big rebounds in the third quarter, over the summer, due in part to assumptions that the Federal Reserve will accelerate its moves to stabilize the financial system and Congress will soon enact another enormous fiscal-stimulus package. But the crisis might not be over by then. A federal-government plan to combat the pandemic estimated that it could last 18 months and hit in "multiple waves" that would require some degree of prolonged social distancing. Modeling by Imperial College London indicated a similar duration.

How Deep is the Drop?
Already at the scale of 2008

"**The economy isn't going to recover before the social distancing is over**," Shierholz said.

And even when life returns to some semblance of normalcy, the economic trauma won't be over.

According to Zandi, at least. **three big waves will hit American economy activity**

1. The first is occurring now, as **businesses close** and the economy grinds to a halt.

2. Next will be the **job losses**.

3. "The third wave will hit when **people realize they are worth so much less**, particularly the Boomers, who are focused on their retirement," Zandi told me. "When they realize their nest egg has evaporated, they'll go into panic mode and cut back on spending, and that further exacerbates the problem."

RUSSELL BERMAN The Economic Devastation Is Going to Be Worse Than You Think. The Atlantic. https://www.theatlantic.com/politics/archive/2020/03/covid-19s-devastating-effects-jobs-and-businesses/608461/

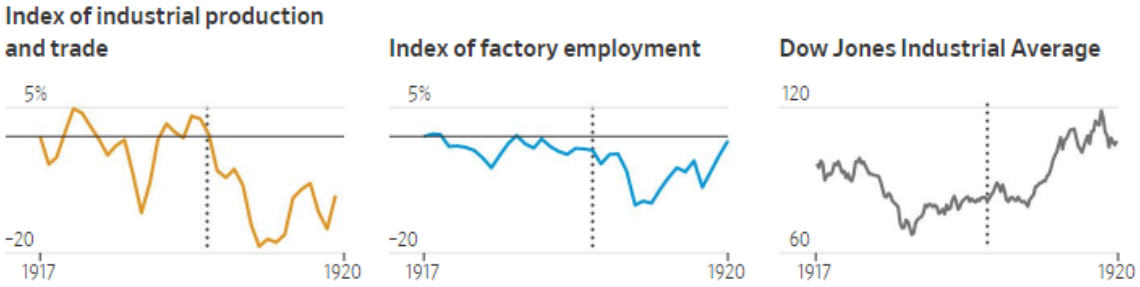
What is the Shape of this Curve?

Is it a "V" or a "U" or an "L"

Can we draw lessons from past experience?

Spanish Flu

Starting in 1918, the Spanish flu would kill 50 million people, or 3 percent of the world's population.



Sources: National Bureau of Economic Research (production, employment), FactSet (stock indexes)

Asian Flu of 1957

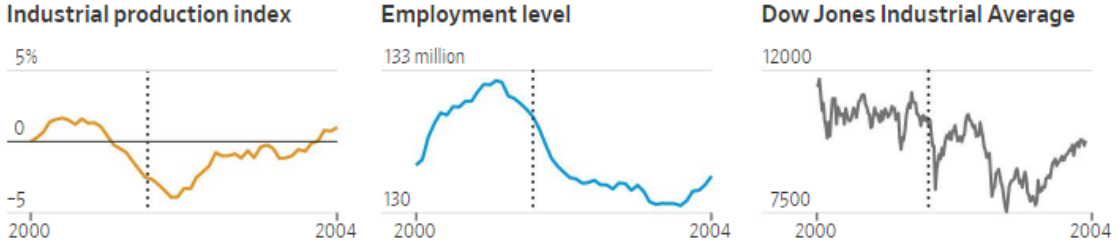
Originating in China, the Asian flu peaked in the U.S. in October, coinciding with a recession.

Note: industrial production and employment are seasonally adjusted
Sources: Federal Reserve (production, employment), FactSet (stock indexes)

Greg Ip, Danny Dougherty and Anthony DeBarros. Lessons for the Coronavirus Crisis From Six Other Disasters, The Wall Street Journal, March 20, 2020. https://www.wsj.com/articles/lessons-for-the-coronavirus-crisis-from-six-other-disasters-11584719497

Sept. 11, 2001 Terrorist Attacks

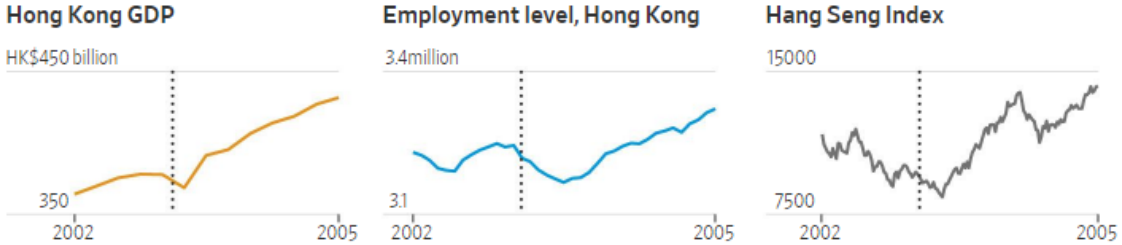
The attacks on the World Trade Center and Pentagon came while the U.S. was already sliding into recession.



Note: industrial production and employment are seasonally adjusted
Sources: Federal Reserve (production, employment), FactSet (stock indexes)

SARS

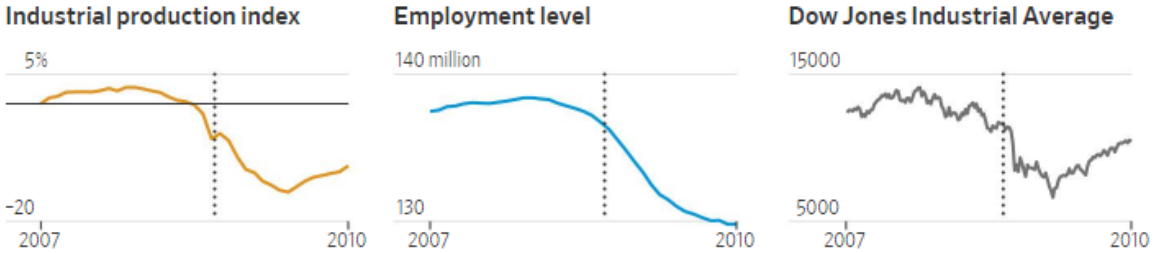
Severe Acute Respiratory Syndrome spread from China to Hong Kong in early 2003.



Note: GDP is in constant 2017 Hong Kong dollars
Sources: CEIC Data (GDP and employment), FactSet (stock indexes)

Global Financial Crisis

The crisis caused a deep recession and was ended with extensive bailouts.



Note: industrial production and employment are seasonally adjusted
Sources: Federal Reserve (production, employees), FactSet (stock indexes)

Lessons from Past Disasters

There is no clear historical precedent
Nonetheless, previous crises offer clues

Ultimately, the severity of the economy's slowdown depends on the length and seriousness of the pandemic. But Torsten Slok, chief economist at Deutsche Bank Securities, says consumers will continue to be cautious even after authorities signal the all clear.

A strong rebound — what economists call a V-shaped recovery, as opposed to a U-shaped one with an extended low — would require a profound resurgence in confidence. But few see that on the horizon.

"**There is a risk that the psychology has changed**," Mr. Slok said. "People will be very reluctant to do a lot of travel and spending and may want to save for another day. There will be more caution."

Nelson D. Schwartz. Coronavirus Recession Looms, Its Course 'Unrecognizable' The New York Times, March 21, 2020. https://www.nytimes.com/2020/03/21/business/economy/coronavirus-recession.html

A few lessons stand out.

First, **governments and the public always face a trade-off between economic stability and public health and safety**. The more they prioritize health and safety, the bigger the near-term cost to the economy, and vice versa.

Second, at the outset of the disaster, **policy makers are coping with enormous uncertainty. Early responses are often timid or off-target and more sweeping action is delayed by political disagreement**. "We learned that we need to prioritize speed, think in tranches, be visible and worry about how to pay for it later," said Tim Adams who served in the Treasury Department during 9/11 and Hurricane Katrina and is now president of the Institute of International Finance. "If you wait to craft the perfect response, you'll lose valuable time and you'll miss something no matter what."

Third, **disasters often create permanent changes to habits**, and the most affected industries and regions can take years to recover.

Greg Ip, Danny Dougherty and Anthony DeBarros. Lessons for the Coronavirus Crisis From Six Other Disasters, The Wall Street Journal, March 20, 2020. https://www.wsj.com/articles/lessons-for-the-coronavirus-crisis-from-six-other-disasters-11584719497

Federal Response? Localized Problem?

This week, the Danish government told private companies hit by the effects of the pandemic that it would pay 75 percent of their employees' salaries to avoid mass layoffs.

The plan could require the government to spend as much as 13 percent of the national economy in three months. That is roughly the equivalent of a $2.5 trillion stimulus in the United States spread out over just 13 weeks.

The philosophy here is that **the government wants companies to preserve their relationship with their workers.**

It's going to be harder to have a strong recovery if companies have to spend time hiring back workers that have been fired.

The plan will last for three months, after which point they hope things come back to normal.

Derek Thompson, Denmark's Idea Could Help the World Avoid a Great Depression "We are freezing the economy." The Atlantic. MARCH 21, 2020. https://www.theatlantic.com/ideas/archive/2020/03/denmark-freezing-its-economy-should-us/608533/

"This is not just a blip," Mr. Daco said of the outlook. "We've never experienced something like this."

"**Even during previous recessions," noted Ellen Zentner, chief U.S. economist at Morgan Stanley, "no one's been told you can't go outside or you can't gather**."

Smaller companies will be hit harder than large ones because of their limited access to credit and less cash in the bank. "There will be a swath of small businesses that simply won't be able to survive this," Ms. Zentner added.

One reason that things could get so bad so quickly is that **economic weakness feeds on itself,** with demand falling as more businesses shut their doors and layoffs spread.

The pain is so severe because the economy is dominated by services, with consumers powering overall demand, a shift from previous generations, when the production of goods counted for a greater share of output. About three-quarters of economic activity derives from consumer spending, and half of that is at risk, Mr. Daco said.

Nelson D. Schwartz. Coronavirus Recession Looms, Its Course 'Unrecognizable' The New York Times, March 21, 2020. https://www.nytimes.com/2020/03/21/business/economy/coronavirus-recession.html

The Economic Issues

this is not like past crises

1. **Unprecedented pace of decline**

2. **US has a service economy, in collapse**

3. **Global supply chains are everywhere**
   - only as good as their weakest link
   - pandemic is global, others cannot be expected to meet our schedule

4. **Supply and demand side crash**
   - supply chains breaking
   - business closing, people losing jobs
   - people curtail spending, market contracts, lending curtailed

5. **Differential effect on sectors**
   - health sector, critical infrastructure, essential business
   - everyone else

6. **Recovery depends on economic factors AND**
   - success of public health policy
   - rapid and widespread testing
   - market re-entry for people with immunity
   - federal investment

7. **People will be changed by this event**

Prioritizing Action
three categories

1. **Immediate**
   - tactical response for health sector (8X – 30X scale up)
   - rate relief
   - grid reliability (different patterns of grid use)
   - address inequality (sheltering, dependence on ICT)

2. **Midterm (go now to be there in time)**
   - crisis
     - recession will hit, budgets lag
     - critical gaps in supply chains will be discovered
     - more vulnerable to secondary hazards
   - seize opportunities
     - resilience has meaning
     - strategic intervention (harnessing skill sets)
     - partnerships (sectors, departments, research)
     - policy window (e.g., clean energy, inequality)

3. **Long-run (direction for your mid-term movement)**
   - new normal (e.g., 10-40% increased ICT demand)
   - shifting patterns of demand (question reliability)
   - critical infrastructure is being redefined
   - generational change

Immediate Action

your assets and the skills of your people

1. **Tactical Response for Health sector (8X – 30X scale up)**
2. **Rate relief**
3. **Grid reliability (different patterns of grid use)**
4. **Address inequality (sheltering, dependence on ICT)**

- Scientists must be heard
- Stop transmission between cities
- Stop transmission within cities
- Fix the testing mess
- Isolate the infected
- Find the fevers
- Trace the contacts
- Make masks ubiquitous
- Preserve vital services
- Produce ventilators and oxygen
- Retrofit hospitals
- Decide when to close schools
- Recruit volunteers
- Prioritize the treatments
- Find a vaccine
- Reach out to other nations

Donald G. McNeil Jr. The Virus can be stopped, but only with Harsh Steps, Experts Say, New York Times, March 22, 2020.

Early signals from New York and Seattle are alarming: both cities are already reporting intensive care unit bed shortages and looming ventilator shortages, weeks before the estimated peak of the projected coronavirus caseload

Daniel M. Horn, How America Can Avoid Italy's Ventilator Crisis, March 22, 2020.
https://www.nytimes.com/2020/03/22/opinion/health/ventilator-shortage-coronavirus-solution.html

The amounts **that internet usage has jumped by varies from country to country. In the US city of Seattle there have been increases of around 40 per cent when compared the pre-Covid-19 times**; Italy has seen a rise rise of around 30 per cent.

Matt Burgess, No, coronavirus isn't going to break the internet, Wired, Saturday 21 March 2020.
https://www.wired.co.uk/article/coronavirus-internet-speed-shut-down

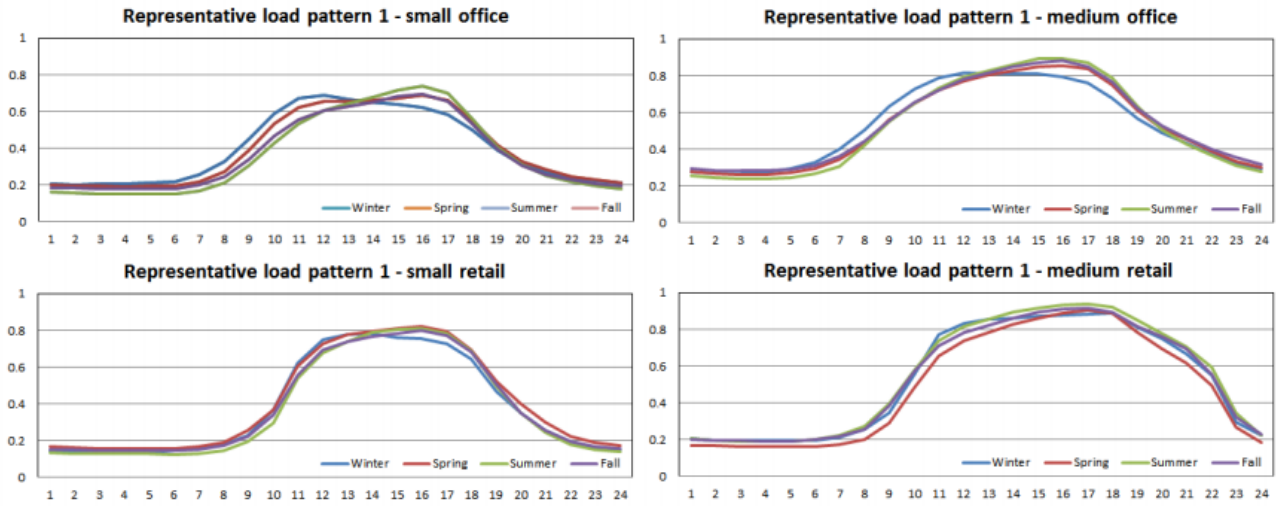


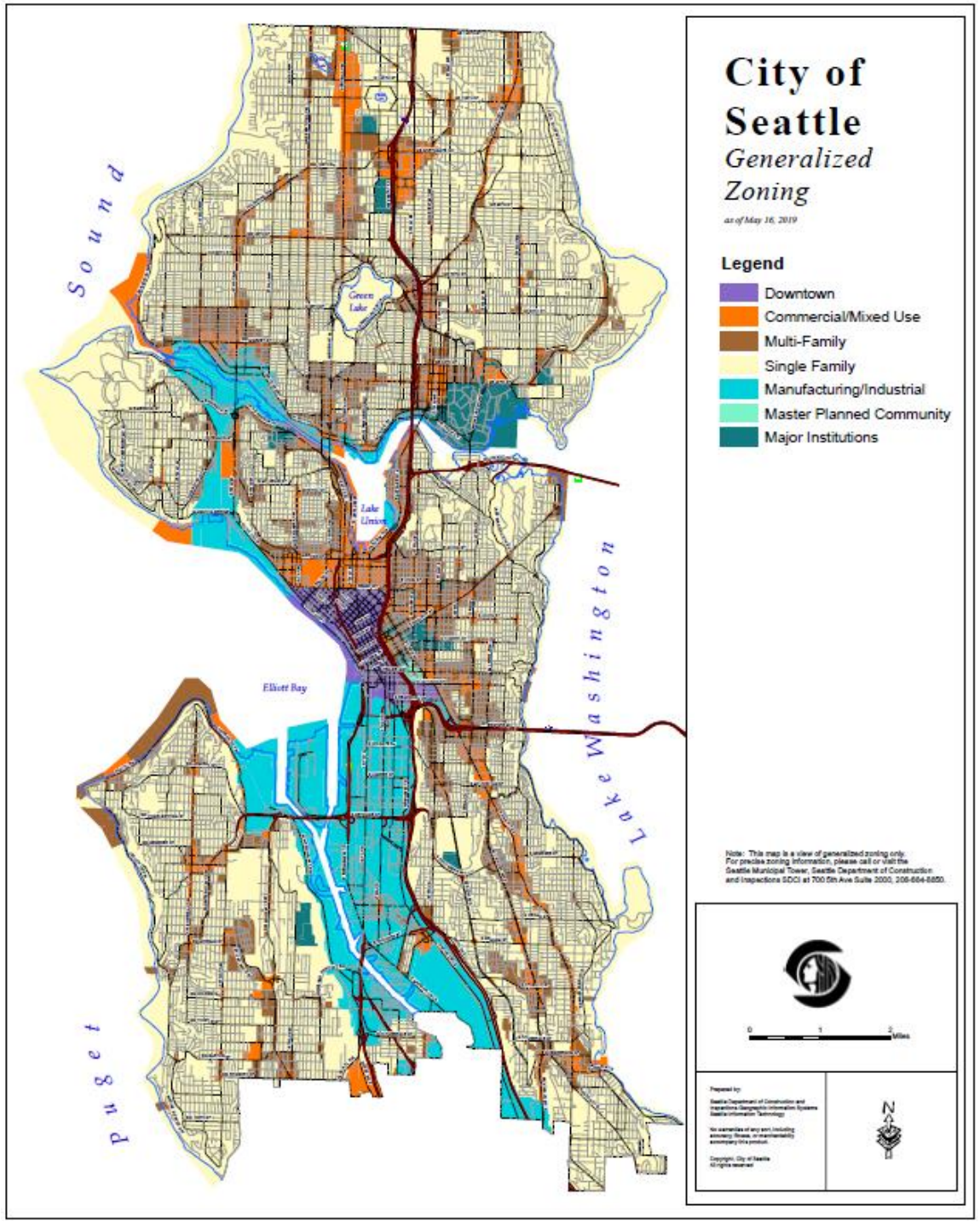
Figure 9 Seasonal representative load patterns of each building category

Xuan Luo, Tianzhen Hong, Yixing Chen, Mary Ann Piette, *Electric Load Shape Benchmarking for Small- and Medium-Sized Commercial Buildings*, Lawrence Berkeley National Labs, March 2017.

Midterm (go now)
to be there in time

1. **Crisis is here**
   - recession will hit, budgets lag
   - critical gaps in supply chains will be discovered
   - more vulnerable to secondary hazards

2. **It is creating opportunities**
   - resilience has meaning
     - Emergencies will be more deeply understood, and somewhat redefined
   - strategic intervention (harnessing skill sets)
     - What differences do you want to make as a public sector utility?
     - What skills do you have, or now see that you need?
   - partnerships (sectors, departments, research)
     - Enlist partners now to help with questions that you will want answers to over the next 3 – 6 months and beyond
   - policy window (e.g., clean energy, inequality)



Long-run (look now)
to know where you are going

1. **New normal**
   - e.g., 10-40% increased ICT demand
2. **Shifting patterns of demand (question reliability)**
   - Reliability, shelter in place, all hazards approach
3. **Critical infrastructure is being redefined**
   - Essential business?
4. **Generational change**
   - Crises leave impressions

How to define this crisis?

- recession will hit, budgets lag
- critical gaps in supply chains will be discovered
- more vulnerable to secondary hazards

How to recognize opportunities?

- resilience has meaning
- strategic intervention (harnessing skill sets)
- partnerships (sectors, departments, research)
- policy window (e.g., clean energy, inequality)

Broadly speaking, these are the kinds of businesses that could be deemed essential:

- grocers, restaurants offering takeout or delivery, convenience stores, liquor stores, hardware stores, warehouses and distributors
- health care providers and pharmacies
- gas stations, banks, laundromats and dry cleaners
- child care providers
- animal shelters and veterinary services
- **utilities, telecommunications and transportation providers**
- auto repair, plumbers and other skilled contractors, construction companies and many kinds of manufacturers
- funeral homes, crematories and cemeteries

Kwame Opam, It's Not 'Shelter in Place': What the New Coronavirus Restrictions Mean, The New York Times, March 20, 2020. https://www.nytimes.com/article/what-is-shelter-in-place-coronavirus.html

Parts of the Economy at Risk:

- Financial Markets
- Retail
- Travel and Hospitality
- Technology (non-essential)
- Automobiles/Aerospace

Goods w/global supply chains

SYLVAN LANE. 5 parts of the economy most at risk from coronavirus. The Hill. 03/01/20, https://thehill.com/policy/finance/485247-5-parts-of-the-economy-most-at-risk-from-coronavirus

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Covid-19 and Infrastructure

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